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(54) Method and apparatus for eyetrack-driven text enlargement

(57) Apparatus, methods, systems and computer program products are disclosed that automatically expands the computer displayed information that interests a computer user. Thus making the information easier for the user to see. The computer detects which area on a display device has the user's interest by using a gaze-tracking device to monitor where the user looks on the display. After determining which area interests the user the invention expands the display of the information in that area.

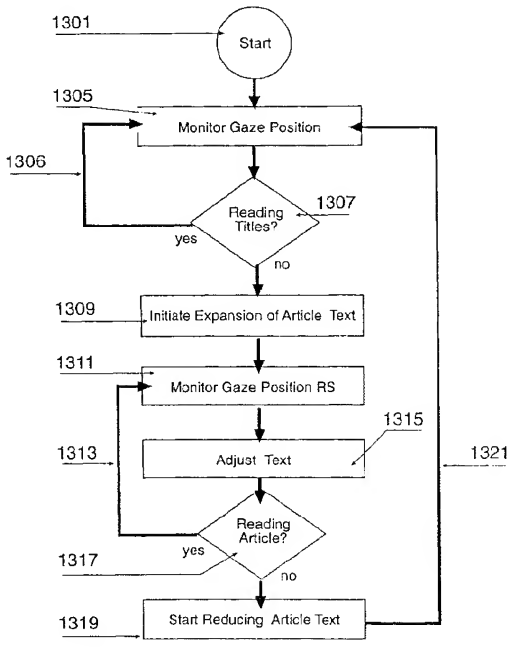

FIGURE 13

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Description

Background of the Invention

Field of the Invention

This invention relates generally to the field of computer-human user interface technology and more particularly to a method, apparatus, system and computer program product for allowing a computer to automatically determine what aspect of the computer's operation has the user's interest and to optimize that aspect.

Background

Human/Computer Interaction

An important characteristic of modern computing systems is the interface between the human user and the computer. Early interactive interfaces were text based wherein a user communicated with the computer by typing a sequence of characters on a keyboard and the computer communicated with the user by displaying characters on an output device-commonly a display screen. These input characters specified a command to the computer's operating system or to an application program executing on the computer. This command invoked program logic to perform a given operation. Modern computer systems use a graphical user interface (GUI) to simplify the interaction between a user and a computer. A GUI equipped computer communicates with a user by displaying graphics, including text and icons, on a display screen and the user communicates with the machine both by typing in textual information in response to dialogs and by manipulating the displayed icons with a pointing device, such as a mouse.

Many modern GUIs provide a window environment. In a typical window environment the graphical display portrayed on the display screen is arranged to resemble the surface of an electronic "desktop" and each application program running on the computer is represented as one or more electronic "paper sheets" displayed as rectangular regions on the display screen. These rectangular regions are called "windows". Each window may include a multitude of panes. Each pane being an area for a particular type of information (textual, still image, moving image, etc.).

Each window displays information generated by an associated application or system program. Further, there may be several windows simultaneously present on the desktop with each containing information generated by a program. A program presents information to the user through each window by drawing or "painting" images, graphics or text within the window. The user can also move a window to a different location on the display screen and change its size and appearance to arrange the desktop in a convenient manner. The user communicates with the program by "pointing at" objects displayed in the window with a cursor controlled by a pointing device and manipulating the objects as desired. In some cases the program requests additional information from the user in response to a manipulation. This request is presented as a "dialog" that allows the user to provide the requested information to the dialog from the keyboard.

Each window typically includes a number of standard graphical objects such as sizing boxes, buttons and scroll bars. These features represent user interface controls that the user can manipulate with the pointing device. When the controls are selected or manipulated, the GUI invokes program logic in the underlying program to effect a corresponding command.

One characteristic of a GUI is that the GUI is only responsive to a user's explicit manipulation of the pointing device or keyboard. In the case of a mouse, the user physically moves the mouse device and a cursor on the display moves accordingly. Some pointing devices actually track the user's gaze and move the cursor to where the user "looks" on the display screen. However, even with the gaze tracking (eye tracking) devices, the GUI only responds to the user's explicit commands whether that command be a button press, a blink, or a shift of view. The computer remains a tool that the user operates by issuing explicit commands.

In contrast, humans have the ability to make inferences by looking at another human's eyes. Pupils dilate when people see something attractive. People look at what they are interested in and stare at things they find interesting. Also, human eye movements reflect thought processes. Thus, humans observe what other persons do with their eyes and make inferences as to what that other person is interested in and/or thinking.

The prior art in computer-human interfaces does not determine the user's immediate interest. Prior art computer-human interfaces simply respond to a user's command, whether input by typing the command at a keyboard, by manipulating a mouse to move a cursor, or by using a gaze tracking device to move a cursor. Thus, the computer is unable to detect or anticipate what characteristic of the computer's operation is of most interest to the user at any given time.

Gaze Tracking Devices

Most gaze tracking devices operate based upon the principal that the direction of a person's gaze is directly related to the relative positions of the pupil and the reflection of an object off the cornea (gaze tracking is often termed eye tracking). These devices often include image processing capabilities that operate on a video image of an eye to determine the gaze direction of the eye. These image processing capabilities are enhanced by using the bright eye affect.

The bright eye affect is a result of the highly reflective nature of the retina This characteristic of the retina means that a significant amount of the light that enters

an eye is reflected back through the pupil. Thus, when light shines into an eye along the axis of a camera lens, the retina reflects a significant portion of the light back to the camera. Hence, the pupil appears as a bright disk to the camera. This affect allows the pupil to be more readily imaged from a video of an eye.

Other methods exist for gaze tracking. Some incorporate having two video cameras, one for tracking head movement and the other for measuring a reflection off of the eyes. Other mechanisms involve measuring electric potential differences between locations on different sides of an eye. High accuracy devices are very intrusive on the user and require that the user's head be held in a fixed position or that the user wear special equipment to track the eye.

Recently, an eyegaze eyetracking system has been developed as described in *The Eyegaze Eyetracking System - Unique Example of a Multiple-Use Technology,* 4th Annual 1994 IEEE Dual-Use Technologies and Applications Conference, May, 1994. This system comprises a video camera located below a computer display that monitors one of the user's eyes. The device also contains an infrared light emitting diode (LED) located at the center of the camera's lens to maximize the bright-eye affect. Image processing software on the computer computes the user's gazepoint on the display sixty times a second with an accuracy of about a quarter inch.

Gaze tracking devices have been used for weapon control, operator training, usability analysis, market research, and as an enablement for the disabled. However, gaze tracking devices have not been used to determine what characteristic of a computer's operation interests the computer user at a particular time or to allow the computer to adapt to a user's interest as demonstrated by where on the display screen the user is looking.

Text to Speech

Many modern computers now provide text-to-speech capability. This capability processes text strings and produces understandable audio speech from the computer's audio output device (headphones or speaker). This capability allows a computer to present an audio version of a text string to a computer user.

Problems with Downloading Information

The background of the World Wide Web (WWW) and WWW browsers are well described by reference to the first chapter of *Instant HTML Web Pages,* by Wayne Ause, Ziff-Davis Press, ISBN 1-56276-363-6, Copyright 1995, pages 1-15, hereby incorporated by reference as illustrative of the prior art.

Using the Internet, a computer user has access to an immense amount of information. However, retrieving this information over the Internet often takes significant time because of the limited bandwidth of the communication channel. The bandwidth is limited by many factors. Some of these factors are the bandwidth of the communication link from the user's computer to the Internet, the bandwidth of the communication link from the information provider's computer to the Internet, the existence of other communication traffic on these links, and the bandwidth of the Internet itself. Often, the primary bandwidth limitation is at the user's computer.

This bandwidth limitation at the user's computer is exacerbated because multiple data streams often flow across this limited communication link. If the user is interested in a particular data transfer, these additional data streams utilize bandwidth that would otherwise be available to the data stream-of-interest to the user. This results in a decreased data transfer rate of the data stream-of-interest.

Prior art WWW browsers, for example, generally attempt to equally allocate bandwidth to all the data transfers directed towards visible views in a window. Although this approach is clearly better then simply sequentially retrieving data for each view, this approach delays retrieving data that is of the most interest to the user because the available channel bandwidth is divided between the data streams supplying data to the views. Thus, the user must wait an additional time because of uninteresting information using bandwidth that could have been applied to the information of interest.

During the transmission of large amounts of data, a program generally provides some indication of the progress of the transmission. This indication is provided by indicators such as bar indicators, numerical percentage indicators, or in the case of images often just the amount of detail available in the displayed image. While waiting for the transfer to complete, the user often watches the progress of the indicator or of the partially-filled image.

As mentioned above, one problem with the prior art is that a user has little control over the bandwidth allocated to the data stream used to download information. Further, even if an application should provide this control to the user, the user still must explicitly command the application to set the allocated bandwidth.

The invention addresses these problems.

Problems with Additional Data Associated with Images

In print and computer hypertext documents, images such as pictures and illustrations, are often provided with additional information, such as captions explaining or enhancing the image. Those who view the image cannot look at the image and read an associated caption at the same time. Thus, the viewer's attention is diverted from the image while searching for, and reading, the associated caption. Contrast this situation with a directive time-dependent medium, such as film or video, where a viewer is simultaneously presented with both visual and audio information. Audio captioning presents additional information though an audio speaker allowing the

user to receive additional information auditorally without distracting the viewer's gaze from the image of interest. Systems that allow a user to select which image to view, from a plurality of images, require the user to explicitly trigger the vocal caption. Thus, the user is again distracted from looking at the image by the need to seek out and activate the caption.

The invention addresses these problems.

Problems with Small Text Displayed to a User

People often have difficulty reading text on a computer display screen. Often this is due to vision difficulties. Thus, the type used in WYSIWYG (what you see is what you get) applications is often too small for comfortable reading at the display distance. Further, publishers use different type sizes as a layout tool that indicates importance. Thus, there is a large variation in text size and screen space used between the largest headline text and the text of an article. To address this problem, some applications allow the WYSIWYG text to be magnified. Examples of word processing programs that provide this capability are Microsoft's Word® and Adobe's FrameMaker® programs. However, these programs require the user to explicitly specify, either directly or indirectly, the desired magnification factor. Further, the magnification process reduces the amount of the page that can be displayed on the computer display at the same time because the percentage of the page that is displayed to the user is reduced when the page is magnified. This problem is exacerbated with applications that display WYSIWYG versions of newspapers and magazines because these applications generally attempt to maintain the WYSIWYG page layout and the displayed page is uniformly magnified. To see the entire page, the article text is generally reduced to unreadable size.

The page layout of newspapers and magazines is important. To attract the interest of a large number of readers, the publishers of newspapers present a large number of articles on the first few pages. One way to increase the number of articles on a page is to decrease the amount of space used for the article. In a traditional newspaper, this is accomplished by moving subsequent parts of the article to different pages. This allows the reader to quickly scan articles that the editor believes to be most relevant and to read in depth those articles that the reader finds interesting. Further, where articles are placed on a page influences the order that articles are viewed. Electronic newspapers have these same characteristics.

Additionally, electronic newspapers, like traditional newspapers, use different type styles and sizes to indicate the relative importance of headlines and subheaders. Thus, there is a wide disparity between the largest and smallest text displayed to the reader. Moreover, even large computer displays have a smaller display area than is available to a traditional newspaper thus reducing the area available to the publisher for articles.

Nevertheless, a computer display must often carry the same amount of information as a newspaper. Thus, mapping the content of a newspaper onto a display screen reduces the size of the type used for the articles to the point where the text of the article is extremely difficult to read. Further, the magnification method used by word processing programs for globally expanding the displayed text does not work well when presenting many articles on a page because magnifying the entire page, and providing a limited view into the page distances the structure of the page from the viewer. Thus, globally expanding the text is incompatible with presenting as many articles as is desired on the page. Further, globally expanding the page also expands the larger title and headline text more than is needed to make this text readable and at a cost of consuming undue display space that could otherwise be used to present additional information. Thus, there is a need for a mechanism that optimizes the text size for a reader while still preserving the structural indications provided by the page layout.

The invention addresses these problems.

Problems with Selecting Relevant Information for a User

Another aspect of electronic newspapers, briefly mentioned above, is that of selecting information content for the newspaper. Information content includes both articles about particular items of interest and advertising information. information content is a major reason why people select different paper-based magazines and newspapers. These traditional information providers present the information that they believe interest their readers. Traditional newspapers and magazines are static once printed. Thus, each edition is the same for all those who read it and each copy of a particular edition distributed to a particular region has the same articles, the same layout and the same advertising as all the other copies distributed to the region. This advertising and information content can be customized to the particular region. However, this regionalization can only be carried so far as it is extremely expensive to customize a newspaper or magazine to the particular individual interests of each reader. Thus, some of the information selected for a region will not interest some readers.

Intangible electronic newspapers need not be constrained by the above mentioned limitations inherent in using a tangible paper medium. However, electronic newspapers still target most advertising and information content to a particular market and not to the particular interests of an individual reader. Even where the reader of an electronic publication is provided with a means to customize the content of the electronic paper the user must explicitly specify the content. Further, by explicitly specifying the content, the user may not be presented with other related information that falls just outside of the specification but that could be of interest to the read-

er.

The invention addresses these problems.

Summary at the Invention

The present invention provides an economical, apparatus, method, system and computer program product for providing enhanced facilities to computer users. This invention provides a way for a computer to monitor the user to determine what aspect of the computer operation the user is interested in and to respond accordingly.

One aspect of the invention is a computer controlled method for displaying a portion of some of a plurality of articles to a computer user. The computer is equipped with a display device and a gaze-tracking device. The gaze-tracking device being capable of determining a gaze position on said display device. The computer controlled method displays portions of articles on the display device. Next the method detects an article of interest by determining an intersection between the gaze position and a portion of one of the articles. Finally, the method expands the displayed portion of the article of interest on the display.

In another aspect of the invention, an information presentation apparatus is disclosed having a central processing unit, memory, a display device and a gaze tracking device capable of determining a gaze position on the display device. The apparatus includes a display mechanism than is configured to display portions of a plurality of articles on the display device. The apparatus also includes a detection mechanism that detects an intersection of a portion of one of the displayed articles with the user's gaze and thus determines an article of interest to the user. Finally, the apparatus includes an expansion mechanism that expands the portion of the article of interest on the display device.

Yet another aspect of the invention discloses an information presentation system. The system includes a gaze-tracking device that determines a gaze position on the display device where the user is looking. The system includes a display mechanism that displays portions of articles on a display device. Additionally, the system includes a detection mechanism that determines an article of interest by detecting an intersection between the gaze position and a portion of a displayed article. Finally, the system includes an expansion mechanism that expands the displayed portion of the article of interest.

A final aspect of the invention discloses a computer program product having computer readable code embodied in a computer usable storage medium. The computer readable code causes a computer to effect a gaze position determination mechanism used to determine a gaze position from gaze coordinates returned from a gaze-tracking device. Further the invention includes code that displays portions of a number of articles on a display device and detects when the gaze position intersects one of these portions. This article containing that intersected portion is the article of interest. Finally, the invention includes code that expands the intersected portion of the article of interest.

The foregoing and many other objects and advantages of the present invention will no doubt become obvious to those of ordinary skill in the art after having read the following detailed description of the preferred embodiments which are illustrated in the various drawing figures.

Description of the Drawings

Figure 1	illustrates a portion of a computer system, including a CPU and a conventional memory in which the present invention may be embodied;
Figure 2	illustrates a display device fitted with gaze tracking equipment;
Figure 3	illustrates aspects of a gaze position in accordance with a preferred embodiment;
Figure 4	illustrates the process for determining a gaze position as used in accordance with a preferred embodiment;
Figure 5	illustrates the operation of the invention to allocate bandwidth to an area of interest in accordance with a preferred embodiment;
Figure 6	illustrates the process used to change the bandwidth of a data stream based upon a gaze position in accordance with a preferred embodiment;
Figures 7a & b	illustrate audio captioning in accordance with a preferred embodiment;
Figure 8	illustrates extraction of an image caption from a page of text in accordance with a preferred embodiment;
Figures 9	illustrates the process used to implement captioning in accordance with a preferred embodiment;
Figure 10	illustrates the form of an electronic newspaper;
Figure 11	illustrates text magnification and page layout in accordance with a preferred embodiment;
Figure 12	illustrates text magnification and page layout in accordance with a second preferred embodiment;
Figure 13	illustrates the process of expanding text in response to the users interest in the text in accordance with a preferred embodiment;
Figure 14	illustrates the process for adjusting

the layout of a display as a result of expanded text in accordance with a preferred embodiment;

Figure 15 illustrates a possible first page of an electronic newspaper showing articles and an advertisement in accordance with a preferred embodiment;

Figure 16 illustrates a possible second page of an electronic newspaper showing information determined to be of interest to the reader in accordance with a preferred embodiment; and

Figure 17 illustrates the process used to evaluate the information of interest to a reader and to select new information matching the readers interest in accordance with a preferred embodiment.

Description of the Preferred Embodiments

Notations and Nomenclature

The following "notations and nomenclature" are provided to assist in the understanding of the present invention and the preferred embodiments thereof.

Advertisement - Information provided about a commercial product or service with the purpose of informing the viewer about the product or service so as to lead to a commercial transaction. A type of article.

Article - A complete piece of writing often identified with a title.

Bandwidth - The amount of information that can be passed across a communication channel in a given period of time (usually designated in reference to a second).

Dialog - A specialized window that is used to obtain additional information from the user. A dialog is often used to obtain options and parameters that are computer dependent. A good example is a print dialog that is evoked by a print menu command. The print dialog allows the user to specify what printer options are to be used for a particular print job. Generally the dialog allows the user to specify specific parameters and then to either affirm or cancel the command that evoked the dialog. If the user cancels the command, the dialog window is removed and the command that evoked the dialog is aborted. If the user confirms the command the user provided information acquired by the dialog is used in the execution of the command that evoked the dialog.

E-mail system - Electronic mail system. A system of computers generally connected by a network that allow a sender (being a user of a first computer) to compose and send data making up a message to a recipient (being a user of either the first computer or of a second computer).

Graphical User Interface (GUI) - A user interface that allows a user to interact with a computer display by pointing at selectable control areas on the display and activating a command or computer operation associated with the selectable control area. GUIs are well known in the art.

Gaze position - An area of interest on the screen providing a boundary of the user's gaze over a limited period of time.

Gaze coordinates - The coordinates that represent the intersection of the user's gaze with the display screen over a limited period of time.

Gaze coordinates (raw) - The coordinates that represent the instantaneous intersection of the user's gaze with the display screen.

Image - Any information displayed on a display screen such as, but not limited to, pictures, drawings, illustrations, text, and video. An image generally displayed in a view contained in a window. A still image is a picture. A moving image is comprised of a number of frames of still images that are played in sequence similar to a video

Pointing device - A device responsive to a computer user's input that moves an indicator on a computer display screen. Such an indicator has an active point such that if the pointing device is activated (e.g., by a button push for a mouse device) a command associated with the selectable control area covered by the active point is invoked. Pointing devices are generally used with graphical user interfaces.

Selectable control area - An area on a computer display that is sensitive to activation of a pointing device. On activation of the pointing device over the selectable control area, a command or computer operation associated with the selectable control area is invoked. Most computer systems that provide a Graphical User Interface (GUI) also provide other methods for invoking these commands or computer operations such as keyboard function keys or command lines.

URL - A Uniform Resource Locator. URLs are used to access information on the World Wide Web.

View - An area in a window where information is provided.

Window - An area, usually rectangular, on a computer display screen controlled by an application.

Procedure - A self-consistent sequence of steps leading to a desired result. These steps are those requiring physical manipulation of physical quantities. Usually these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. These signals are referred to as bits, values, elements, symbols, characters, terms, numbers, or the like. It will be understood by those skilled in the art that all of these and similar terms are associated with the appropriate physical quantities and are merely convenient labels applied to these quantities.

Overview

The manipulations performed by a computer in executing opcodes are often referred to in terms, such as adding or comparing, that are commonly associated with mental operations performed by a human operator. In the present invention no such capability of a human operator is necessary in any of the operations described herein. The operations are machine operations. Useful machines for performing the operations of the invention include programmed general purpose digital computers or similar devices. In all cases the method of computation is distinguished from the method of operation in operating a computer. The present invention relates to method steps for operating a computer in processing electrical or other (e.g., mechanical, chemical) physical signals to generate other desired physical signals.

The invention also relates to apparatus for performing these operations. This apparatus may be specially constructed for the required purposes or it may comprise a general purpose computer as selectively activated or reconfigured by a computer program stored in the memory of a computer. The procedures presented herein are not inherently related to a particular computer or other apparatus. In particular, various general purpose machines may be used with programs written in accordance with the teachings herein, or it may prove more convenient to construct more specialized apparatus to perform the required method steps. The required structure for a variety of these machines will appear from the following description. Also, the invention may be embodied in a computer readable storage medium encoded with a program that causes a computer to perform the programmed logic.

Operating Environment

Figure 1 illustrates a computer system referenced to by the general reference character **102,** configured to support the invention. The system **102** includes a processor **133** having an Input/Output ("I/O") section **135,** a central processing unit ("CPU") **137** and a memory section **139**. The I/O section **135** is connected to a keyboard **141**, a disk storage unit **143,** a network interface **145** to provide access to a network **117**, a display unit **147**, a pointing device **148,** a gaze-tracker device **155**, a speaker **157** and a CD-ROM drive unit **149.** The CD-ROM unit **149** can read a CD-ROM medium **151** that typically contains a plurality of programs **153** and data. The CD-ROM **149** and the disk storage unit **143** comprising a filestorage mechanism. One skilled in the art will understand that the filestorage mechanism may comprise read only memory, RAM or other storage technology that allows a computer to access data. Such a computer system is capable of executing programmed logic that embodies the invention.

Gaze Tracker Operation

Figure 2 illustrates a gaze tracking device **201** attached to a computer display device **203.** As illustrated, the gaze tracking device **201** is mounted below the computer display **203** and comprises a video lens **205,** with an infrared LED **207** mounted on the center of the lens **205.** One skilled in the art will understand that one of many different types of gaze tracking devices can be used with the invention. The computer display device **203** has a display area **209** that the computer can access to display information. The computer generally creates a plurality of windows **211** and **213** for this informational display. As the user looks at the display area **209,** the gaze tracking device determines the users gaze position. The gaze coordinate (raw) is an ordered pair of values providing the immediate two dimensional coordinates of where the user's gaze is positioned on the screen. A number of gaze coordinates can be used to develop a gaze position that is a two dimensional coordinate of a time weighted average of the gaze coordinates. The invention need not have precise gaze coordinates. In fact the gaze coordinates need only be accurate to approximately a 1/4 inch. One skilled in the art will understand that the gaze position could also be returned as a rectangle, polygon, circle or other shape representing an area of interest. Further one skilled in the art will understand that the gaze tracking device **201** may be configured to provide the gaze position only when the user has shown interest in a displayed area for a sufficient time, or that application or system program logic may be utilized to detect when the user has shown an interest by monitoring the gaze coordinates over some period of time. The gaze position is developed when the system detects that the user has become interested in a particular area of the display. The system detects this condition by recognizing that the user's gaze has been limited to a particular region of the displayable area **209** for a period of time.

Figure 3 illustrates aspects of a gaze position determined from gaze coordinates returned from a gaze tracking device. The dashed rectangle labeled as **301** indicates the boundaries of an image (not shown). Because the gaze tracking device has an uncertainty and because the user's gaze constantly moves (because of involuntary eye movements) even when focused on an area of interest, this embodiment of the invention provides the gaze position as an area **305** where the user's gaze is fixed. The provided area **305** indicates that the user's gaze did not leave the specified area for a given time such as a half second. The application program that uses the returned circular area **305** is able to determine that the user's gaze is well within the image **301** because the provided circle is completely contained within the area of the image. If the user has interest in the entire image, the gaze would be more diffused resulting in a larger circle. For example, in comparing the image labeled **301** with an image **311**, the user viewing the image **301** has focused in on a particular aspect of the image as indicated by the circle labeled as **305.** The user viewing the image **311** has indicated more interest in the totality of the image as compared to a particular aspect of the image as indicated by the circle labeled as **309.** One skilled in the art will understand that a rectangle or other area indication can be used as well as a circle.

In another embodiment of the invention, the gaze tracker returns the gaze position as a point. For example, a dashed rectangle labeled as **303** indicates the boundaries of a different image (again this image is not shown). In this embodiment, the gaze tracker, after processing gaze movements over some period of time, simply returns a point that is a time weighted average of the position of the gaze. This point is indicated by the arrow labeled as **307**.

Figure 4 illustrates the process used to develop a gaze position from a plurality of gaze coordinates. The process starts at a terminal **401.** Next at a step **403,** the process performs any necessary setup or initialization. This includes initializing timer program logic to periodically gather instantaneous gaze coordinate data from the gaze tracker apparatus, acquiring user preference data and other one-time initializations. Next at a step **405,** the process receives a plurality of gaze coordinates (raw). These gaze coordinates (raw) indicate the position of the user's gaze over a given time. After a sufficient number of gaze coordinates (raw) are gathered, the process examines the gaze coordinates (raw) for a focus pattern at a branch point **407**. A focus pattern occurs when the gaze coordinates (raw) are all within some boundary without gaze coordinates (raw) being statistically far from the others. If the gaze coordinates (raw) do not show a focused gaze, the gathering of instantaneous gaze coordinates (raw) continues as shown by an arrow **406**. If at the branch point **407** a focus pattern is found then a step **409** determines an area of focus that contains the statistically significant gaze coordinates (raw). Finally, in a step **411** the gaze position is made available to the program logic for use. Finally, the process repeats as shown by an arrow **412.** In the case where the gaze position is presented as an area instead of a simple coordinate pair, the receiving program logic determines which view is overlapped by the gaze position.

There are various well known methods in the art to present the gaze position to program logic such as an application program. These include providing an exception to an application, sending an interprogram message containing the gaze position to the application and many other methods.

An executing computer program can modify its operation to best suit the user's interest by using a gaze tracking device to determine which area of a display screen is the object of a user's attention. Specific embodiments using this capability of the gaze tracker are described below.

Gaze Tracker Mediated Downloading

As mentioned above, prior art communication programs such as WWW browsers and other data transfer programs that provide multiple data streams do not allocate bandwidth depending on the user's specific interest. At best, these programs will allocate bandwidth to images and data that is presented to the user on the display device. The invention enables a computer to detect which data stream the user is interested in and to allocate more bandwidth to that data stream without an explicit command from the user.

Figure 5 illustrates how a preferred embodiment of the invention is used in a WWW browser. The browser application displays a window **501** on the display device. The user invokes a URL to present a webpage containing information encoded in HTML in the window **501.** In this particular example, the webpage shows a plurality of three areas of text **503, 511** and **517** along with a plurality of areas of images **505, 513** and **519**. Each of these images are displayed in a view. Further, these images are constructed from "large data entities". Each large date entity is composed of a large amount of data that is used to define the entity. Examples of large data entities, among others, are high resolution graphical images, sound and video entities. A plurality of shaded areas **507, 509** and **521** of the images **505, 513** and **519** indicate the amount of the image that has been downloaded at some particular point in time prior to completion. If the user is interested in the image labeled as **513**, the user will watch that image **513** fill. Thus, a gaze position area **515** intersects the image **513** thus identifying the image **513** as an area of interest. A complementary approach to determining which image **505, 513** or **519** is of interest is to have the text **503, 511** or **517** associated with each image. Thus, when the user reads the text **511** linked (associated) with an image **513** a gaze position **512** is found on the text. Once the user shows interest in the text, the application can properly assume that the area

of interest is the linked image **513**.

Once the area of interest is determined, the system obtains the bandwidth allocated to the area of interest and, if possible, increases the bandwidth allocation of the data stream directed to the area of interest using techniques well understood in the art.

Figure 6 illustrates the process used to allocate bandwidth to a data stream supplying data to an area of interest. The process starts at a terminal **601.** At a step **603** the process receives the gaze position from a gaze tracking device as described above. Then at a step **605** the gaze position is used to determine what information or view on the display device intersects with the gaze position. Next in a decision block step **607,** the process checks whether the displayed information that intersects the gaze position is relevant. Information that is relevant comprises information that is in the process of being transferred to the display device. In other words, a completely loaded image is not relevant and has no bandwidth allocation because there is no need to increase the bandwidth for an image that has been completely transmitted. Contrast this situation where there is zero bandwidth allocated to a yet-to-be-loaded image. Here the yet-to-be-loaded image has a bandwidth allocation, but the current allocation is zero whereas there is no bandwidth allocation at all for an image that has been completely downloaded. Text is another example of displayed information that usually is not relevant because the user cannot read the text as fast as it is transmitted even with limited bandwidth.

If in the decision block step **607** the displayed information is relevant then, in a step **609** the process determines the area of interest on the display and in a step **611** increases the bandwidth allocated to the data flow associated with the area of interest. Finally, the process completes through a terminal **613.**

However, if in the decision block step **607** the displayed information is not relevant, the source of the displayed information is checked in a decision block step **615** to determine whether the source indicates that the displayed information is associated with an area of interest. An example of this situation is where text is associated with an image. If at the decision block step **615** the source is not associated with an area of interest processing completes through the terminal labeled as **613.** However, if **615** the source is associated with an area of interest, the process **611** increases the bandwidth of data flowing to that area of interest. Finally, the process completes through the terminal **613.**

In a preferred embodiment of a WWW browser, the process illustrated in Figure 6 determines what area of the display device the user is interested in. If that area is a partially downloaded image, the invention increases the bandwidth allocated to the data flow for completing the image. If the area is a textual area whose defining source HTML provides an association with an image (for example, by providing an attribute within the paragraph element that associates a large data entity with the paragraph) the invention increases the bandwidth allocated to the data flow for completing that specific image.

Finally, embodiments utilizing the invention are not limited to WWW browsers. Any application that presents information that is downloaded across a limited bandwidth network onto a display device can use the invention. This includes detecting interest on data transfer status displays generated by programs such as, among others, FTP, Kermit, or x- y- and zmodem applications.

Captioning

Another preferred embodiment of the invention relates to captioning of images. Audio captioning detects the user's interest in a displayed image and automatically provides additional audio information to the user about the displayed image while video captioning provides additional video information.

Figure 7a illustrates captioning. An image of a phone **701** is displayed to the user. If the user is interested in the phone, the user looks at the image **701** thus generating a gaze position from the gaze tracking device. The invention then presents additional information about the phone to the user. In some circumstances, the additional information is electronic information attached to the image by a data structure within the underlying application such as the one shown in Figure 7b. Such additional information may include text, text that is converted to audio, recorded audio data, video data, or another image.

In other circumstances the additional information is a textual caption **703** displayed with the image **701** but without a direct electronic linkage to the captioned image **701.** When the additional information is a displayed textual caption **703,** the invention detects that a textual caption **703** exists for the image **701**, extracts that textual caption **703** and passes the extracted text string to a text-to-speech process that presents the caption text to the user in audio form. Some page markup languages support a <CAPTION> tag. For example, both SGML and HTML support such a tag (note however, that although HTML supports a <CAPTION> tag, it is currently only used for table captions and not for figures). Thus one of the preferred embodiments of the invention uses the <CAPTION> tag to detect the textual caption **703** of an image **701.**

All of these methods provide additional information to the user about an image-of-interest. The audio methods allow the user to maintain his/her attention on the image while receiving additional information auditorally. Many of the other methods of presenting the additional information result in the user removing her/his gaze from the image-of-interest.

Figure 7b illustrates a representative data structure **710** that can be used to associate additional electronic information with an image as mentioned above. An "Image ID" field **711** identifies the image displayed to the user. A "Pointer to Image Data" field **713** contains the

image data, or data that directly or indirectly references the image data used to create the displayed image **701.** A "Pointer to Additional Information" field **715** contains the additional electronic information data, or data that directly or indirectly references the additional electronic information data. This data structure is one of many that can be used by programmed applications that provide an explicit link between an image and additional information. Some programmed applications do not provide such an explicit linkage.

Figure 8 illustrates a window **801** displaying an example page **803.** The page **803** includes text and an image **805** of a phone. The phone image **805** has an associated textual caption **807.** The image **805** and the caption **807** are offset from the text by a plurality of blank areas **809, 811** and **813.** These blank areas **809, 811, 813** delimit the image **805** and its associated textual caption **807** from the rest of the displayed text. This separation allows the underlying application program to determine a linkage between the image and its associated textual caption. Further, even if the underlying programmed application that presented the window **801** does not have the facility to directly determine the link between the caption **807** and the image **805,** other programmed applications can scan the window **801.** After scarring the window these programmed applications then isolate and pass the caption text **807** through a text-to-speech facility to convert the caption text **807** to audio and present the audio to the user.

Figure 9 illustrates the process used to present additional information. The process starts at a terminal **951** when it receives a gaze position from a gaze-tracking device at a step **953**. If at a decision block step **955** the gaze position does not intersect an image, the process completes through a terminal **957**. If at the decision block step **955** the gaze position intersects an image and if at a decision block step **959** the image has an electronic caption, the process accesses and presents the additional information at a step **961**. Finally, the process completes through the terminal **957**. If at the decision block step **959** the image does not have an electronic caption but does have a displayed textual caption as determined in a decision block step **963,** the process extracts the caption text and passes the resulting text string to a text-to-speech facility for auditory presentation to the user in a step **965.** Finally, the process completes through the terminal **957.** If in the decision block step **963** the image does not have a textual caption, or if such a caption cannot be determined, the process completes through the terminal **957.**

One skilled in the art will understand that auditory presentation of the additional information to the user is accomplished with techniques known in the prior art.

Displayed Text Enlargement

A page from an electronic newspaper is illustrated in **Figure 10.** This information is displayed on a computer display screen generally in a window as discussed above. Here a window **1001** contains a headline **1003,** a plurality of four article titles **1005, 1009, 1013** and **1017** and a partial text **1007, 1011, 1015,** and **1019** of the titled articles. A computer for displaying the electronic newspaper that is equipped with a gaze tracking device can rely on the normal reading pattern of a user. That is, that the user first reads the major headline **1003,** then the article title **1005, 1009, 1013** or **1017** followed by the article itself **1007, 1011, 1015,** or **1019**. Thus, when the gaze tracker indicates that the user is reading an article title, the invention starts expanding the article text by a magnification factor to an optimal size for the user.

Figure 11 illustrates two possible embodiments of the invention. As in Figure 10 within a window **1101**, a plurality of four article titles **1105, 1109, 1113, 1117** are displayed. The window **1101** also includes a headline **1103**. An article **1107** has been expanded by the invention to a comfortable size for reading. This expansion has occurred without increasing the size of the window **1101** within which the article **1107** is displayed. However, the view containing the article **1107** and the text of the article **1107** have been expanded. To obtain the necessary window space to expand the view containing the article **1107** without interfering with the expanded view **1107,** the view containing an article **1115** along with its title **1113** have been reduced in size and shifted towards the edge of the window **1101**. The articles associated with the titles **1109** and **1117** have been shifted completely off of the window **1101** leaving only their associated titles **1109** and **1117**.

If the computer detects that the user's gaze has moved from the expanded article **1107,** to a different title **1113, 1109,** or **1117,** the text of the associated article is expanded. At the same time, the text and title of the previously expanded article **1105, 1107** is slowly reduced so that the user's gaze is not attracted by the apparent movement caused by the reductionIn a preferred embodiment of the invention the user may utilize computer commands to cause the reduction and expansion of the articles and their associated title to be instantaneous. Further, the expansion can be to a predetermined user preference. Finally, the expansion of the article can be dynamically determined by monitoring the user's reading speed of the article (by determining how the gaze position changes over time) so as to maximize the reading speed.

Another embodiment of the invention retains the original size of the view, but magnifies the text within the view by a magnification factor. This embodiment does not require the reduction and repositioning of the other articles as does the preferred embodiment However, as the text expands within the limited bounds of the view the amount of text that can be displayed in the unmagnified view is reduced. Further, the maximum magnification of the text is limited in that the essential structure of the left to right reading pattern (for Latin based languages) should be retained for comfortable reading. Too

much magnification of the text within a limited space results in a column of words that is difficult to read.

Figure 12 illustrates another approach to managing the information displayed in a window **1201.** Here, a title **1205** and text of an article AA **1207** is expanded and simply overlays a plurality of other articles **1211, 1215,** and **1219** in the window **1201.** Because the other articles and titles are obscured, the text is reduced when the user's gaze leaves the window **1201** or when the user invokes a command function either by use of a pointing device, a command line or other command invocation method. Because the magnified view overlays the other views, a preferred embodiment places the magnified view within a boarder **1217** to separate the magnified view from the other views.

Figure 13 illustrates the process used to determine when to expand an article. The following description references Figure 10 as an illustrative example. The process starts at a terminal **1301**. At this time the user's gaze has not focused in on a window **1001**. When the user's gaze enters the window **1001,** the process, at a step **1305,** monitors which text is read by the user. So long as the gaze position indicates that the user is reading one of the plurality of titles **1005, 1009, 1013,** and **1017** as determined by a decision block step **1307** the monitoring step **1305** continues as indicated by an arrow **1306.** If the decision block step **1307** detects that the user's gaze changed to a subtitle or the plurality of article text **1007, 1011, 1015, 1019,** the process starts to expand the view and text of the contained article at a step **1309.** The process continues to monitor the user's gaze position at a step **1311** to determine the user's reading speed. Next at a step **1315**, the process adjusts the size of the article text to maximize the user's reading speed possibly continuing the expansion of the view started in the step **1311.** This adjustment uses a magnification factor having a value that is a function of the reading speed. This magnification factor controls the view and the text within the view. Finally at a decision block **1317,** the process determines whether the user's gaze position continues to intersect the view containing the article (that is, to verify that the user continues to read the article). If at the decision block **1317** the user continues to read the article, the monitoring process of the step **1311** continues as indicated by an arrow **1313.** However if at the decision block **1317**, the user has stopped reading the article, the process starts reducing the size of the abandoned article at a step **1319** and the entire process is repeated as indicated by an arrow **1321**. The invention allows the user to reacquire the abandoned article simply by bringing the user's gaze back to the text of the abandoned article. This stops the reduction of the size of the article text and restarts the expansion of the article text at the step **1309** and leading to the text adjustment step **1315**.

In the enlarging and reduction steps above, the text is slowly enlarged and reduced so as not to be a distraction to the user. Thus the change in size does not attract the user's gaze from the article being read. However, the invention also provides the user with commands that accelerate these scaling processes. Further, the maximum size of an expanded article can be specified as a user preference.

Figure 14 illustrates the process used to size the views impacted by the magnification of the view containing the article being read by the user - the active view. The process starts at a terminal **1401**. At a step **1403** the process first determines the new position and size of the active view in response to the change of scale. Based on this new position and size, at a step **1405** the process determines which other views displayed in the window **1001** will be affected by the change in size and position of the active view. Then, at a step **1407,** each affected view is determined and adjusted in a step **1409** to make room for the enlarged active view (where the active view is expanding), or to take up room released by a reduced active view (where the active view is contracting). This process is repeated as indicated by an arrow **1411** for each impacted view. Once the impacted views are adjusted the process continues, as indicated by an arrow **1415**, to adjust the size and position of the active view in a step **1417.** Finally, the process completes through a terminal **1419.** Note that a reduction in the size of the active view occurs to optimize the user's reading speed. This is not the same reduction that results when the user has stopped reading a view and that view contracts because it is no longer the active view.

This aspect of the invention has been described assuming normal English reading patterns (that is, top to bottom, left to right). One skilled in the art will understand that other reading patterns are contemplated by the invention.

Interest Based Information Presentation

Figure 15 illustrates a typical electronic newspaper display. The invention also applies to data search engine displays. Here, a number of articles **1507, 1511, 1515** and **1519** along with their associated titles **1505, 1509, 1513** and **1517** are displayed in views within a window **1501.** Generally a major headline **1503** is also displayed along with a selection of advertising material **1521**. Because the information provider does not know what subjects interest the user, the information provider presents a mixture of articles. Here the "New Chemical Reaction" article **1507,** and the "Quarks" article **1519** are both science and technology related. The other two articles **1515** and **1511** are not. Each article and advertisement contains information that can be categorized in multiple ways. This categorization includes at least one topic classifying the information. These topics are developed and maintained by the information provider. Using gaze tracking, the information provider can determine the user's interest in each displayed article **1505, 1509, 1513** and **1517** and advertisement **1521.** Then, by using the topics categorizing the presented informa-

tion, the information provider can dynamically adjust the selection of subsequent information presented to this user. In the example above, suppose the user read the scientific based articles **1507** and **1519** but did not spend any time reading the other articles **1511** or **1515** or the advertisement **1521.** The information provider populates the next page of information presented to the user with articles and advertisements that have similar topics as the previously read information.

Figure 16 illustrates a possible second page of information. Again, the information is provided within views contained in a window **1601.** Now a plurality of articles **1607, 1611, 1615** and **1619** are all scientific or technology based, but with different levels of difficulty extending from articles of interest to the lay reader to those that are directed toward the advanced elemental particle physicist. Further, both a Major Scientific Headline **1603** and an advertising **1621** can be selected to be of interest to the user. This allows the information provider to narrowly target advertising and articles to each user. Again the information provider can continue to refine and narrow the selection of information presented to the user on subsequent pages depending on the interest shown in a plurality of article titles **1605, 1609, 1613, 1617,** the time spent with reading each article **1607, 1611, 1615** and **1619** and the time spent looking at the advertisement **1621** of the current page.

Figure 17 illustrates the process used to select information for presentation to a user. The process starts at a terminal **1701** after an initial selection of information is displayed to the user. Using the gaze position developed as described above, a step **1705** monitors the user's reading pattern. Further a step **1709**, determines the amount of interest shown by the user in the displayed information. This interest is determined by measuring the user's reading speed, determining whether the user only skimmed the information or read the information in depth, and by measuring the amount of time spent with each article and advertisement. Then in a step **1711,** the process retrieves the topics associated with each displayed information and in a step **1713** correlates these topics with the user's interest. Next in a step **1715**, the process selects additional information based on this correlation. This selection of information is displayed in a step **1717** for the user. Finally, the process completes through a terminal **1719.** In this manner, the user is presented with a customized set of information that reflects the user's interest.

Although the present invention has been described in terms of the presently preferred embodiments, one skilled in the art will understand that various modifications and alterations may be made without departing from the scope of the invention. Accordingly, the scope of the invention is not to be limited to the particular invention embodiments discussed herein, but should be defined only by the appended claims and equivalents thereof.

Claims

1. A computer controlled method for displaying a portion of some of a plurality of articles to a user of a computer; said computer having a display device, and a gaze-tracking device; said gaze-tracking device determining a gaze position on said display device; said computer controlled method comprising the steps of:

   (a) displaying said portion of some of said plurality of articles on said display device;
   (b) detecting an article of interest by determining an intersection between said gaze position and said portion of one of said plurality of articles;
   (c) expanding said portion of said article of interest resulting in an expanded article of interest; and
   (d) displaying said expanded article of interest.

2. The computer controlled method of claim 1 wherein steps (c) and (d) comprise the steps of:

   (c) expanding said article of interest by a magnification factor resulting in said expanded article of interest;
   (d1) displaying said expanded article of interest; and
   (d2) displaying a border enclosing said displayed expanded article of interest.

3. The computer controlled method of claim 2 wherein step (c) further comprises:

   (c1) determining a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
   (c2) adjusting said magnification factor to increase said reading speed.

4. The computer controlled method of claim 1 further comprising:
   (e) adjusting said portion of some of said plurality of articles such that display of said portion does not interfere with display of said expanded article of interest.

5. The computer controlled method of claim 4 wherein step (e) further comprises:
   (e1) shifting display of said portion of some of said plurality of articles to not interfere with display of said expanded article of interest.

6. The computer controlled method of claim 4 wherein step (e) further comprises:
   (e1) reducing display of said portion of some of said plurality of articles to not interfere with display of

said expanded article of interest.

7. The computer controlled method of claim 4 wherein step wherein step (c) comprises the steps of:

(c1) determining a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time;
(c2) adjusting a magnification factor to increase said reading speed; and
(c3) expanding said article of interest by said magnification factor resulting in said expanded article of interest.

8. The computer controlled method of claim 1 wherein said article of interest is displayed in a view and said article of interest comprises textual information; and wherein step (c) comprises:
(c) expanding said textual information within said view resulting in said expanded article of interest.

9. The computer controlled method of claim 8 wherein step wherein step (c) comprises the steps of:

(c1) determining a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time;
(c2) adjusting a magnification factor to increase said reading speed; and
(c3) expanding said textual information within said view by said magnification factor resulting in said expanded article of interest.

10. An information presentation apparatus configured to display a portion of some of a plurality of articles; said information presentation apparatus having a central processing unit (CPU), a memory, a display device, and a gaze-tracking device; said gaze-tracking device capable of determining a gaze position on said display device; said information presentation apparatus comprising:

a display mechanism configured to display said portion of some of said plurality of articles on said display device;
a detection mechanism configured to detect an article of interest by determining an intersection between a gaze position and a portion of one of said plurality of articles displayed by said display mechanism on said display device; and
an expansion mechanism configured to expand said portion of said article of interest resulting in an expanded article of interest displayed on said display device.

11. The information presentation apparatus of claim 10 wherein said expansion mechanism is configured to expand said portion of said article of interest by a magnification factor resulting in said expanded article of interest displayed on said display device; said expansion mechanism further comprises:

a border display mechanism configured to display a border enclosing said displayed expanded article of interest.

12. The information presentation apparatus of claim 11 wherein said expansion mechanism further comprises:

a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
a magnification factor adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

13. The information presentation apparatus of claim 10 further comprising:

an adjustment mechanism configured to adjust said portion of some of said plurality of articles such that display of said portion does not interfere with display of said expanded article of interest.

14. The information presentation apparatus of claim 13 wherein said adjustment mechanism further comprises an article shifting mechanism configured to shift display of said portion of some of said plurality of articles to not interfere with display of said expanded article of interest

15. The information presentation apparatus of claim 13 wherein said adjustment mechanism further comprises an article reduction mechanism configured to reduce display of said portion of some of said plurality of articles to not interfere with display of said expanded article of interest.

16. The information presentation apparatus of claim 13 wherein said expansion mechanism is configured to expand said article of interest by a magnification factor resulting in said expanded article of interest displayed on said display device; said expansion mechanism further comprises:

a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
a magnification adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

17. The information presentation apparatus of claim 10

where said article of interest is displayed in a view and said article of interest comprises textual information; and said expansion mechanism is configured to expand said textual information within said view resulting in said expanded article of interest displayed on said display device.

18. The information presentation apparatus of claim 17 wherein said expansion mechanism is configured to expand said portion of said article of interest by a magnification factor resulting in said expanded article of interest displayed on said display device; said expansion mechanism further comprises:

a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
a magnification adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

19. An information presentation system configured to display a portion of some of a plurality of articles; said information presentation system having a display device and a gaze-tracking device; said gaze-tracking device for determining a gaze position on said display device; said information presentation system comprising:

a display mechanism configured to display said portion of some of said plurality of articles on said display device;
a detection mechanism configured to detect an article of interest by determining an intersection between a gaze position and a portion of one of said plurality of articles displayed by said display mechanism on said display device; and
an expansion mechanism configured to expand said portion of said article of interest resulting in an expanded article of interest displayed on said display device.

20. The information presentation system of claim 19 wherein said expansion mechanism is configured to expand said portion of said article of interest by a magnification factor resulting in said expanded article of interest displayed on said display device; said expansion mechanism further comprises:

a border display mechanism configured to display a border enclosing said displayed expanded article of interest.

21. The information presentation system of claim 20 wherein said expansion mechanism further comprises:

a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
a magnification factor adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

22. The information presentation system of claim 19 further comprising:

an adjustment mechanism configured to adjust said portion of some of said plurality of articles such that display of said portion does not interfere with display of said expanded article of interest.

23. The information presentation system of claim 22 wherein said adjustment mechanism further comprises an article shifting mechanism configured to shift display of said portion of some of said plurality of articles to not interfere with display of said expanded article of interest

24. The information presentation system of claim 22 wherein said adjustment mechanism further comprises an article reduction mechanism configured to reduce display of said portion of some of said plurality of articles to not interfere with display of said expanded article of interest.

25. The information presentation system of claim 22 wherein said expansion mechanism is configured to expand said article of interest by a magnification factor resulting in said expanded article of interest displayed on said display device; said expansion mechanism comprises:

a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
a magnification adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

26. The information presentation system of claim 19 where said article of interest is displayed in a view and said article of interest comprises textual information; and wherein said expansion mechanism is configured to expand said textual information within said view resulting in said expanded article of interest displayed on said display device.

27. The information presentation system of claim 26 wherein said expansion mechanism is configured to expand said textual information within said view by a magnification factor resulting in said expanded

article of interest displayed on said display device; said expansion mechanism further comprises:

a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
a magnification adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

28. A computer program product comprising:

a computer usable storage medium having computer readable code embodied therein for causing a computer to display a portion of some of a plurality of articles on a display device; said computer readable code comprising:
computer readable code devices configured to cause said computer to effect a gaze position determination mechanism configured to determine a gaze position from gaze coordinates returned from a gaze-tracking device;
computer readable code devices configured to cause said computer to effect a display mechanism configured to display said portion of some of said plurality of articles on said display device;
computer readable code devices configured to cause said computer to effect a detection mechanism configured to detect an article of interest by determining an intersection between said gaze position and said portion of one of said plurality of articles displayed by said display mechanism on said display device; and
computer readable code devices configured to cause said computer to effect an expansion mechanism configured to expand said portion of said article of interest resulting in an expanded article of interest displayed on said display device.

29. The computer program product of claim 28 wherein said expansion mechanism is configured to expand said portion of said article of interest by a magnification factor resulting in said expanded article of interest displayed on said display device; said expansion mechanism further comprises:

computer readable code devices configured to cause said computer to effect a border display mechanism configured to display a border enclosing said displayed expanded article of interest.

30. The computer program product of claim 29 wherein said expansion mechanism further comprises:

computer readable code devices configured to cause said computer to effect a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
computer readable code devices configured to cause said computer to effect a magnification factor adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

31. The computer program product of claim 28 further comprising:

computer readable code devices configured to cause said computer to effect an adjustment mechanism configured to adjust said portion of some of said plurality of articles such that display of said portion does not interfere with display of said expanded article of interest.

32. The computer program product of claim 31 wherein said adjustment mechanism further comprises computer readable code devices configured to cause said computer to effect an article shifting mechanism configured to shift display of said portion of some of said plurality of articles to not interfere with display of said expanded article of interest

33. The computer program product of claim 31 wherein said adjustment mechanism further comprises computer readable code devices configured to cause said computer to effect an article reduction mechanism configured to reduce display of said portion of some of said plurality of articles to not interfere with display of said expanded article of interest.

34. The computer program product of claim 31 wherein said expansion mechanism is configured to expand said article of interest by said magnification factor resulting in an expanded article of interest displayed on said display device; said expansion mechanism comprises:

computer readable code devices configured to cause said computer to effect a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and
computer readable code devices configured to cause said computer to effect a magnification adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

35. The computer program product of claim 28 where said article of interest is displayed in a view and said

article of interest comprises textual information; and wherein said expansion mechanism is configured to expand said textual information within said view resulting in said expanded article of interest displayed on said display device.

36. The computer program product of claim 35 wherein said expansion mechanism is configured to expand said textual information within said view by a magnification factor resulting in said expanded article of interest displayed on said display device; said expansion mechanism further comprises:

computer readable code devices configured to cause said computer to effect a reading speed determination mechanism configured to determine a reading speed by monitoring said gaze position within said portion of said article of interest over a period of time; and

computer readable code devices configured to cause said computer to effect a magnification adjustment mechanism configured to adjust said magnification factor to increase said reading speed.

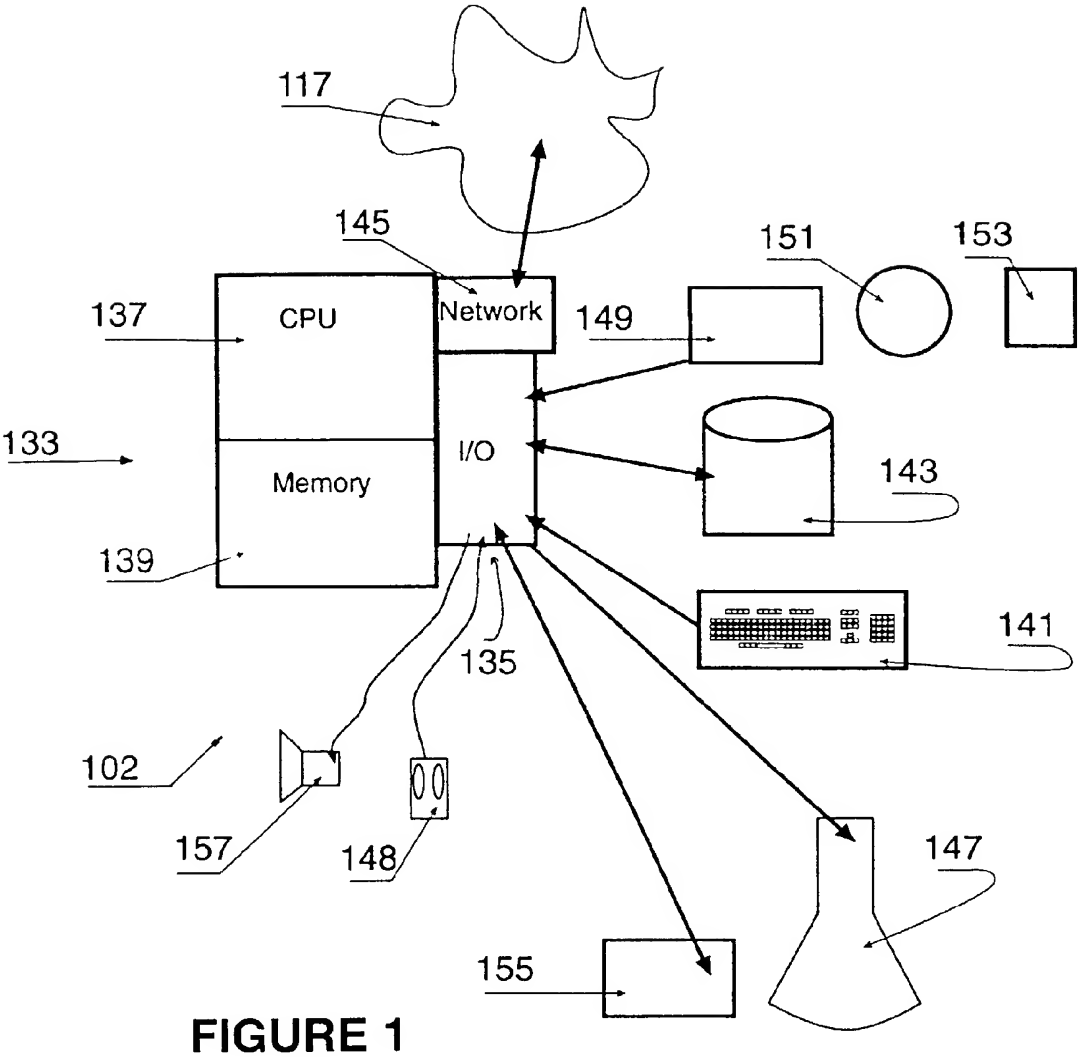

117
145
151
153
137
CPU
Network
149
133
I/O
Memory
143
139
141
135
102
157
148
147
155

FIGURE 1

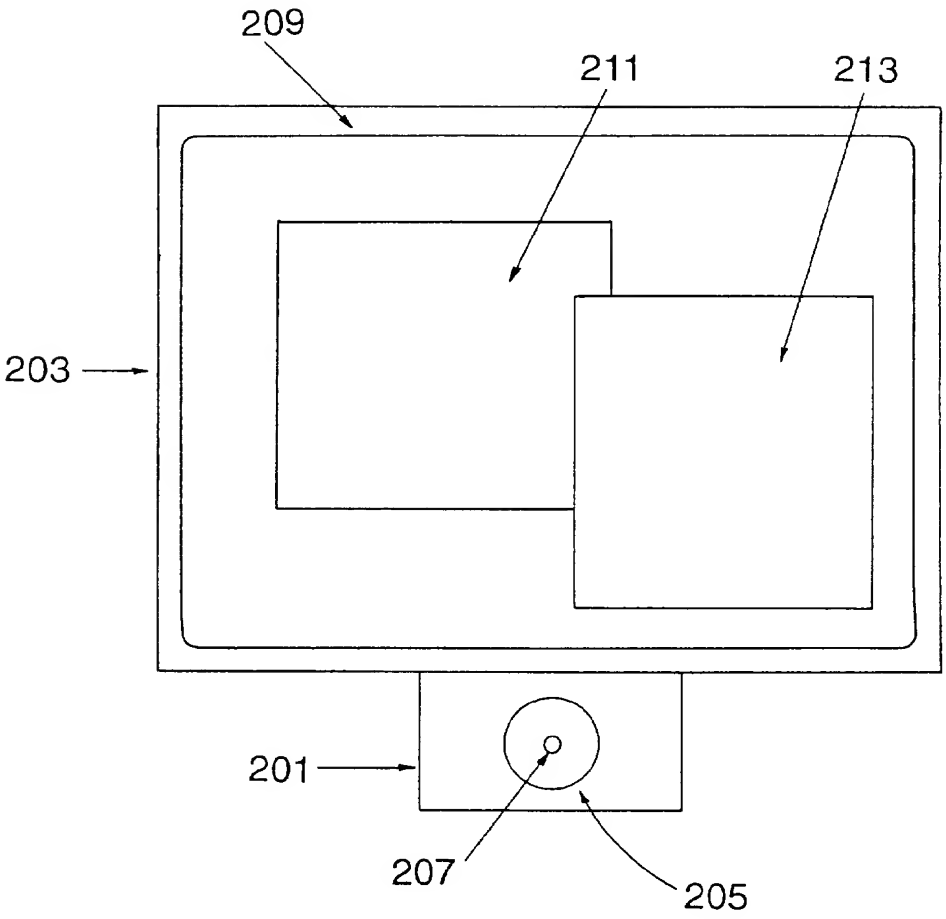


FIGURE 2

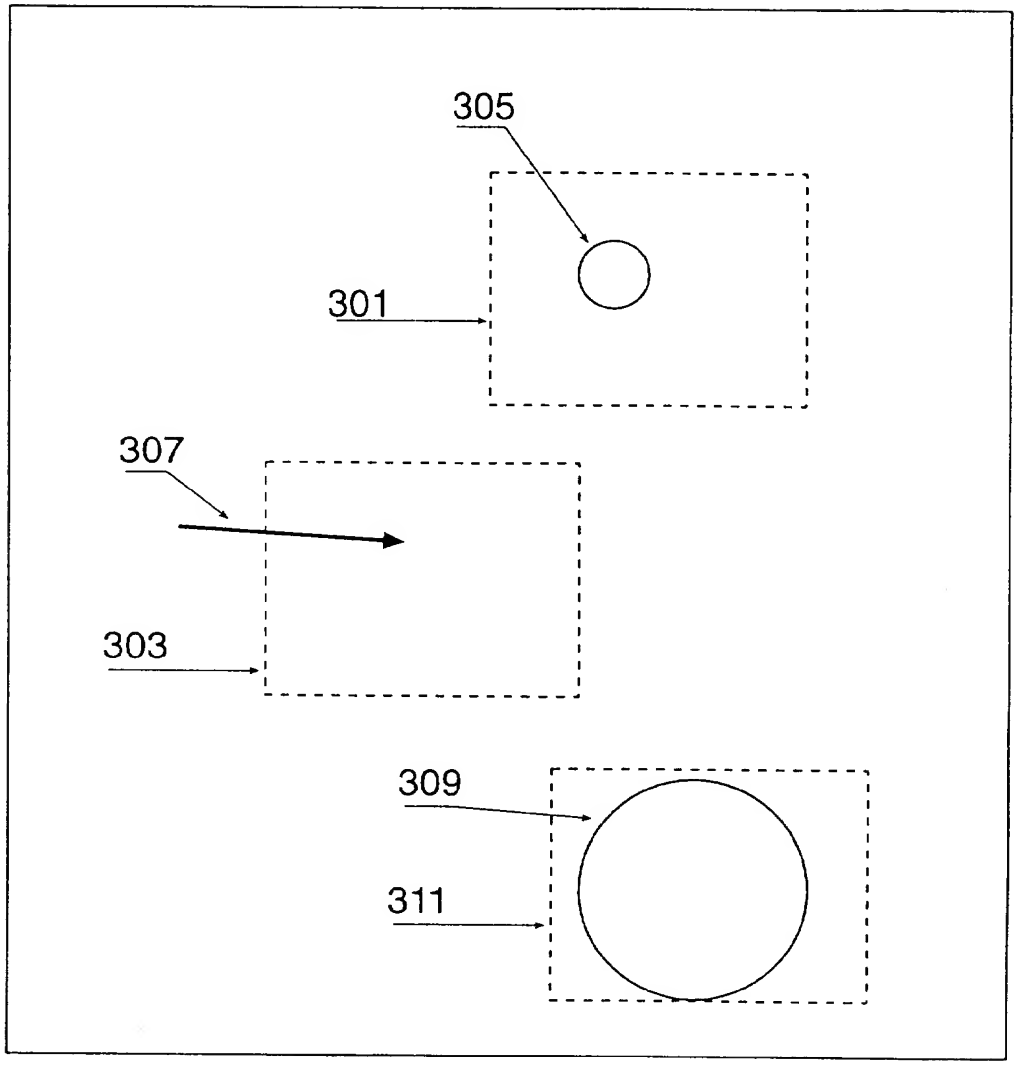
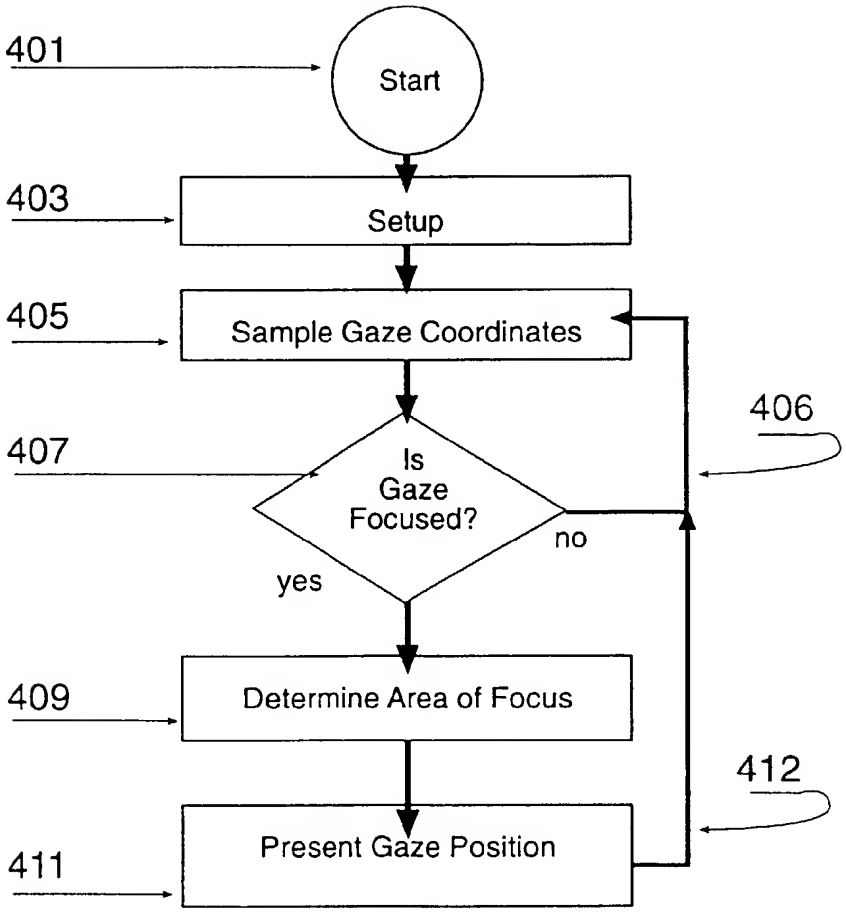


FIGURE 3

FIGURE 4


401
Start
403
Setup
405
Sample Gaze Coordinates
406
407
Is
Gaze
Focused?
no
yes
409
Determine Area of Focus
412
411
Present Gaze Position

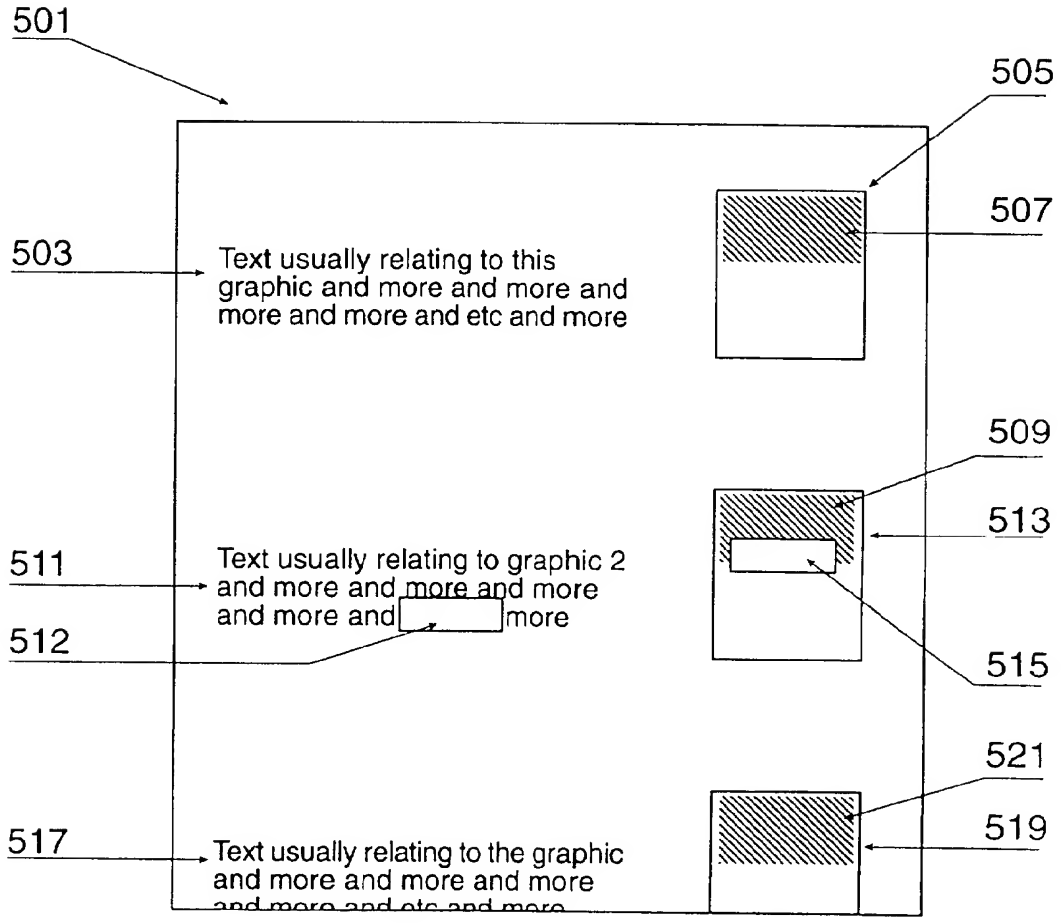

501
505
507
503
Text usually relating to this graphic and more and more and more and more and etc and more
509
513
511
Text usually relating to graphic 2 and more and more and more and more and more
512
515
521
519
517
Text usually relating to the graphic and more and more and more

FIGURE 5

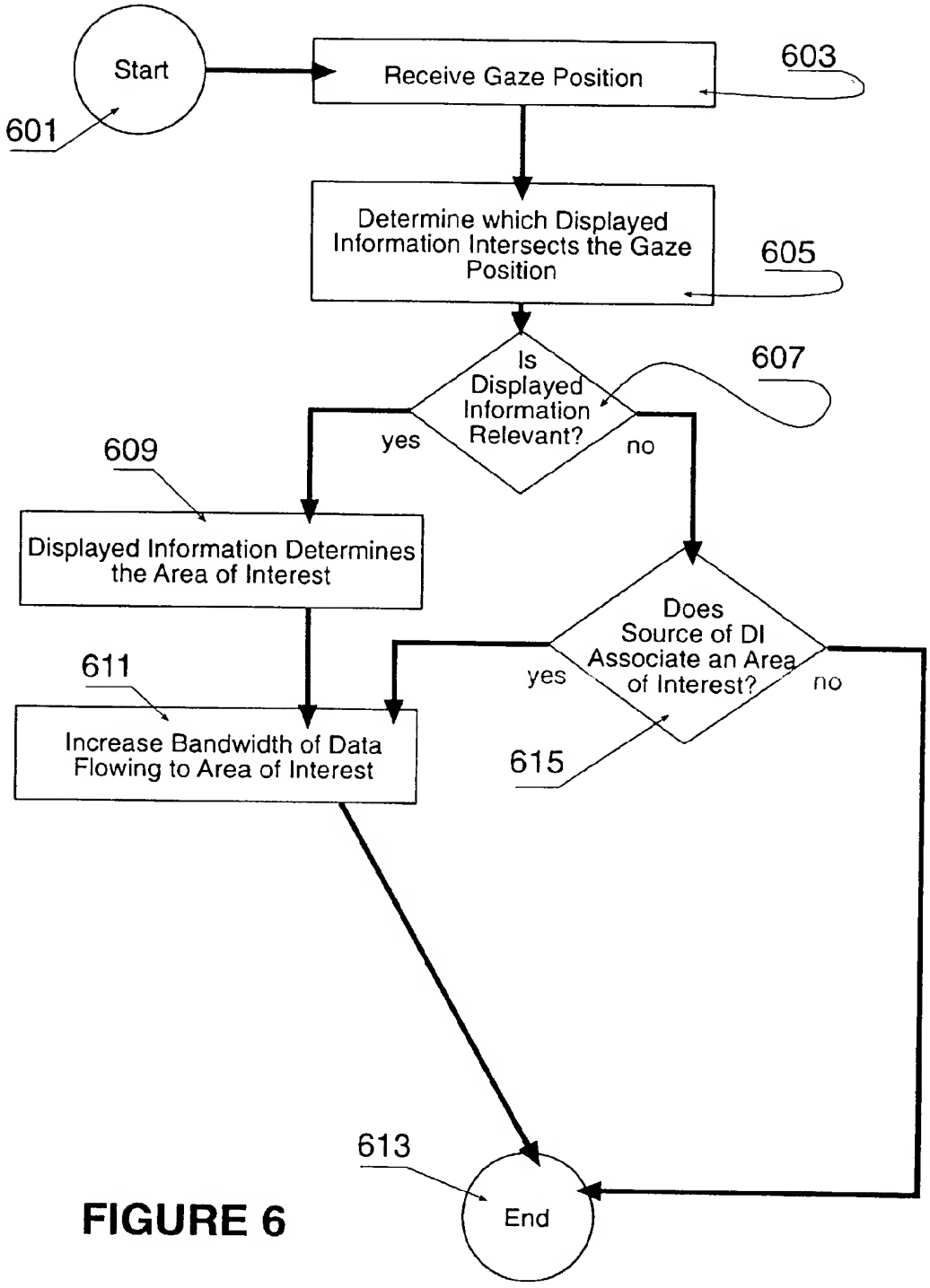

Start
601
Receive Gaze Position
603
Determine which Displayed Information Intersects the Gaze Position
605
Is Displayed Information Relevant?
607
yes
no
609
Displayed Information Determines the Area of Interest
Does Source of DI Associate an Area of Interest?
yes
no
611
Increase Bandwidth of Data Flowing to Area of Interest
615
613
End

FIGURE 6

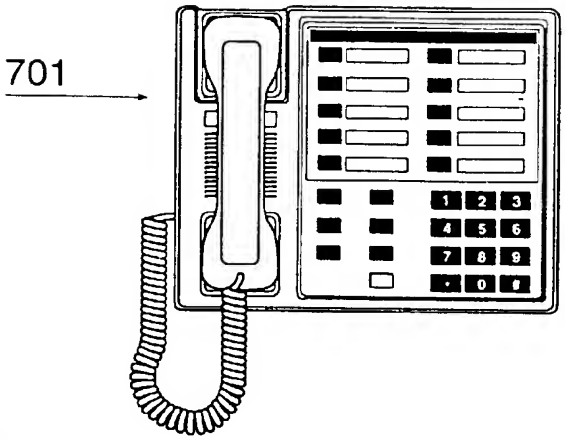


FIGURE 7a

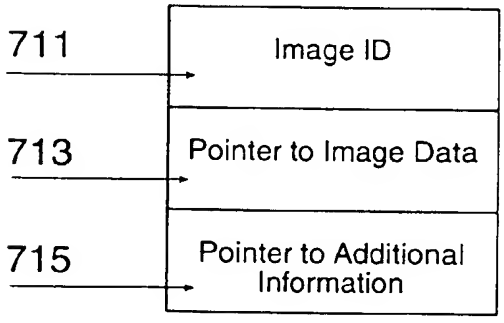


FIGURE 7b

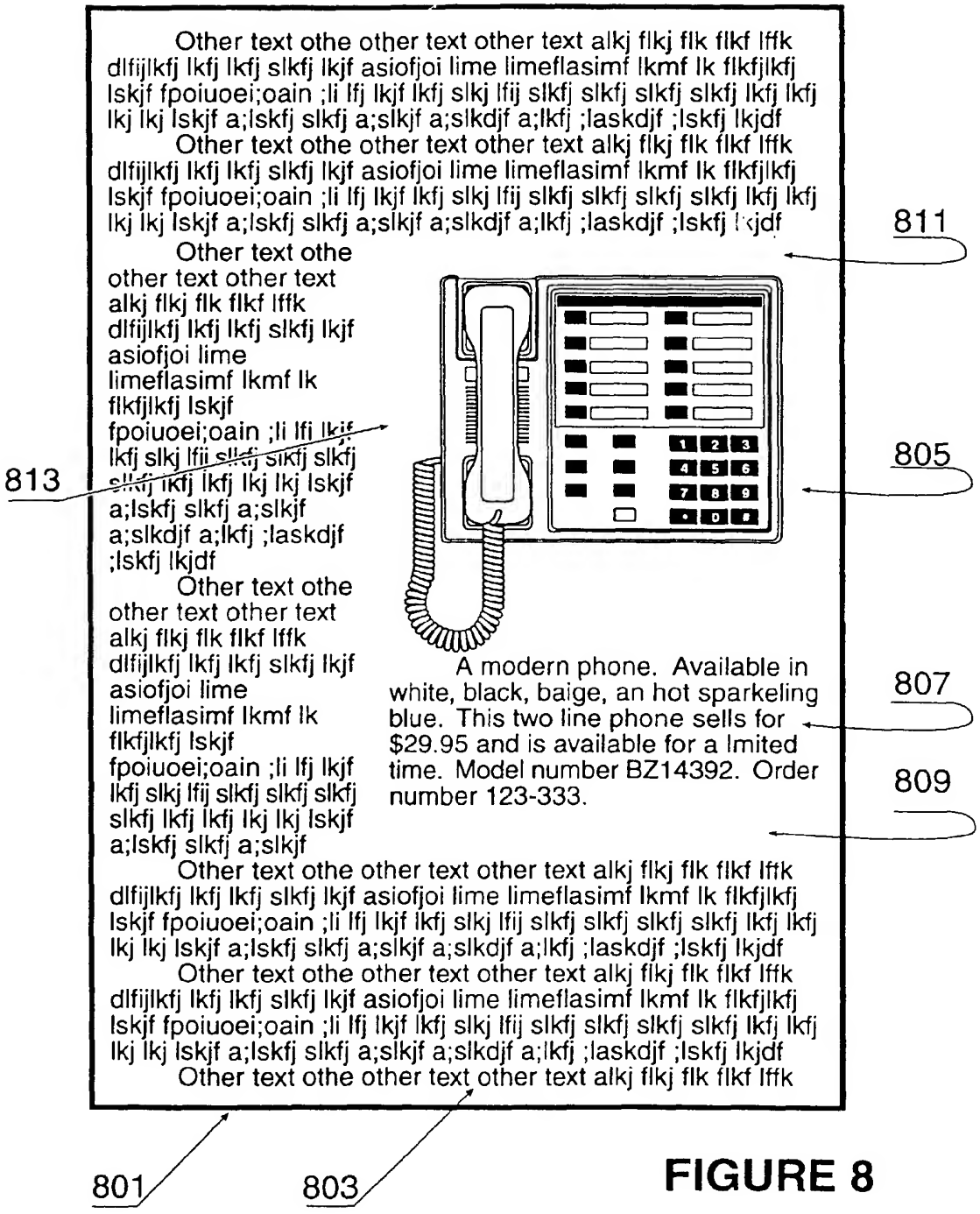

Other text othe other text other text alkj flkj flk flkf lffk dlfijlkfj lkfj lkfj slkfj lkjf asiofjoi lime limeflasimf lkmf lk flkfjlkfj lskjf fpoiuoei;oain ;li lfj lkjf lkfj slkj lfij slkfj slkfj slkfj slkfj lkfj lkfj lkj lkj lskjf a;lskfj slkfj a;slkjf a;slkdjf a;lkfj ;laskdjf ;lskfj lkjdf
Other text othe other text other text alkj flkj flk flkf lffk dlfijlkfj lkfj lkfj slkfj lkjf asiofjoi lime limeflasimf lkmf lk flkfjlkfj lskjf fpoiuoei;oain ;li lfj lkjf lkfj slkj lfij slkfj slkfj slkfj slkfj lkfj lkfj lkj lkj lskjf a;lskfj slkfj a;slkjf a;slkdjf a;lkfj ;laskdjf ;lskfj lkjdf
811
Other text othe other text other text alkj flkj flk flkf lffk dlfijlkfj lkfj lkfj slkfj lkjf asiofjoi lime limeflasimf lkmf lk flkfjlkfj lskjf fpoiuoei;oain ;li lfj lkjf lkfj slkj lfij slkfj slkfj slkfj slkfj lkfj lkfj lkj lkj lskjf a;lskfj slkfj a;slkjf a;slkdjf a;lkfj ;laskdjf ;lskfj lkjdf
813
805
Other text othe other text other text alkj flkj flk flkf lffk dlfijlkfj lkfj lkfj slkfj lkjf asiofjoi lime limeflasimf lkmf lk flkfjlkfj lskjf fpoiuoei;oain ;li lfj lkjf lkfj slkj lfij slkfj slkfj slkfj slkfj lkfj lkfj lkj lkj lskjf a;lskfj slkfj a;slkjf a;slkdjf a;lkfj ;laskdjf ;lskfj lkjdf
A modern phone. Available in white, black, baige, an hot sparkeling blue. This two line phone sells for $29.95 and is available for a lmited time. Model number BZ14392. Order number 123-333.
807
809
Other text othe other text other text alkj flkj flk flkf lffk dlfijlkfj lkfj lkfj slkfj lkjf asiofjoi lime limeflasimf lkmf lk flkfjlkfj lskjf fpoiuoei;oain ;li lfj lkjf lkfj slkj lfij slkfj slkfj slkfj slkfj lkfj lkfj lkj lkj lskjf a;lskfj slkfj a;slkjf a;slkdjf a;lkfj ;laskdjf ;lskfj lkjdf
Other text othe other text other text alkj flkj flk flkf lffk dlfijlkfj lkfj lkfj slkfj lkjf asiofjoi lime limeflasimf lkmf lk flkfjlkfj lskjf fpoiuoei;oain ;li lfj lkjf lkfj slkj lfij slkfj slkfj slkfj slkfj lkfj lkfj lkj lkj lskjf a;lskfj slkfj a;slkjf a;slkdjf a;lkfj ;laskdjf ;lskfj lkjdf
Other text othe other text other text alkj flkj flk flkf lffk
801
803

FIGURE 8

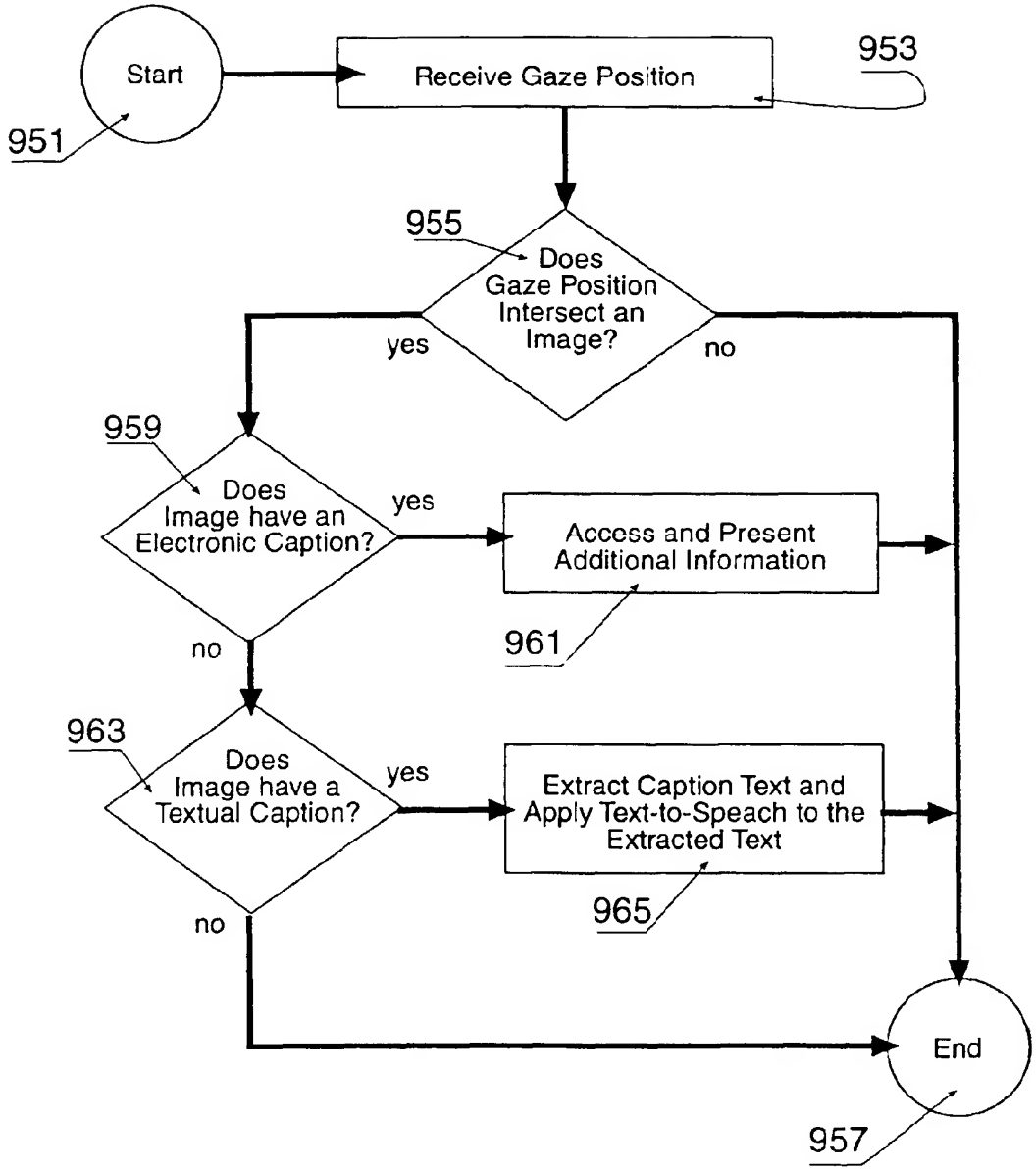

Start
951
Receive Gaze Position
953
955
Does Gaze Position Intersect an Image?
yes
no
959
Does Image have an Electronic Caption?
yes
Access and Present Additional Information
961
no
963
Does Image have a Textual Caption?
yes
Extract Caption Text and Apply Text-to-Speach to the Extracted Text
965
no
End
957

FIGURE 9

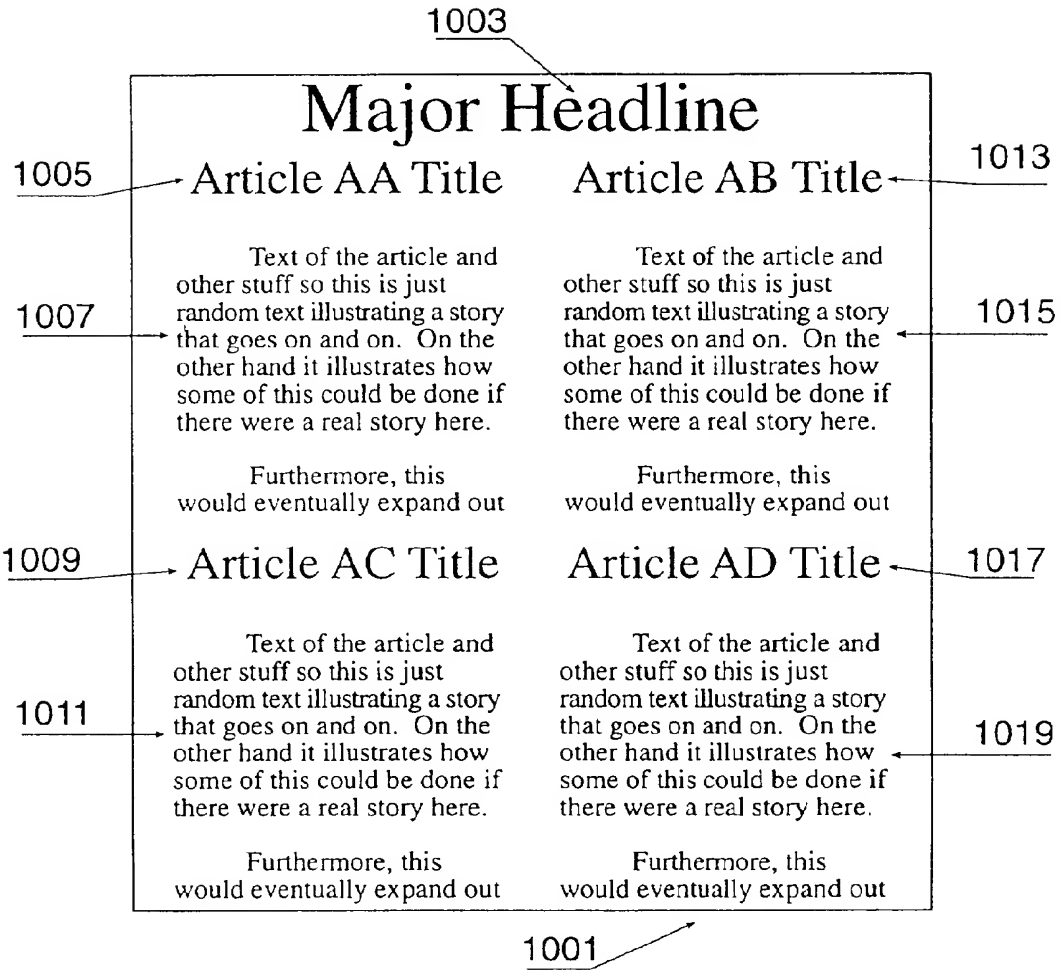

1003
Major Headline
1005
Article AA Title
Article AB Title
1013
Text of the article and other stuff so this is just random text illustrating a story that goes on and on. On the other hand it illustrates how some of this could be done if there were a real story here.
Furthermore, this would eventually expand out
1007
1015
1009
Article AC Title
Article AD Title
1017
1011
1019
1001

FIGURE 10

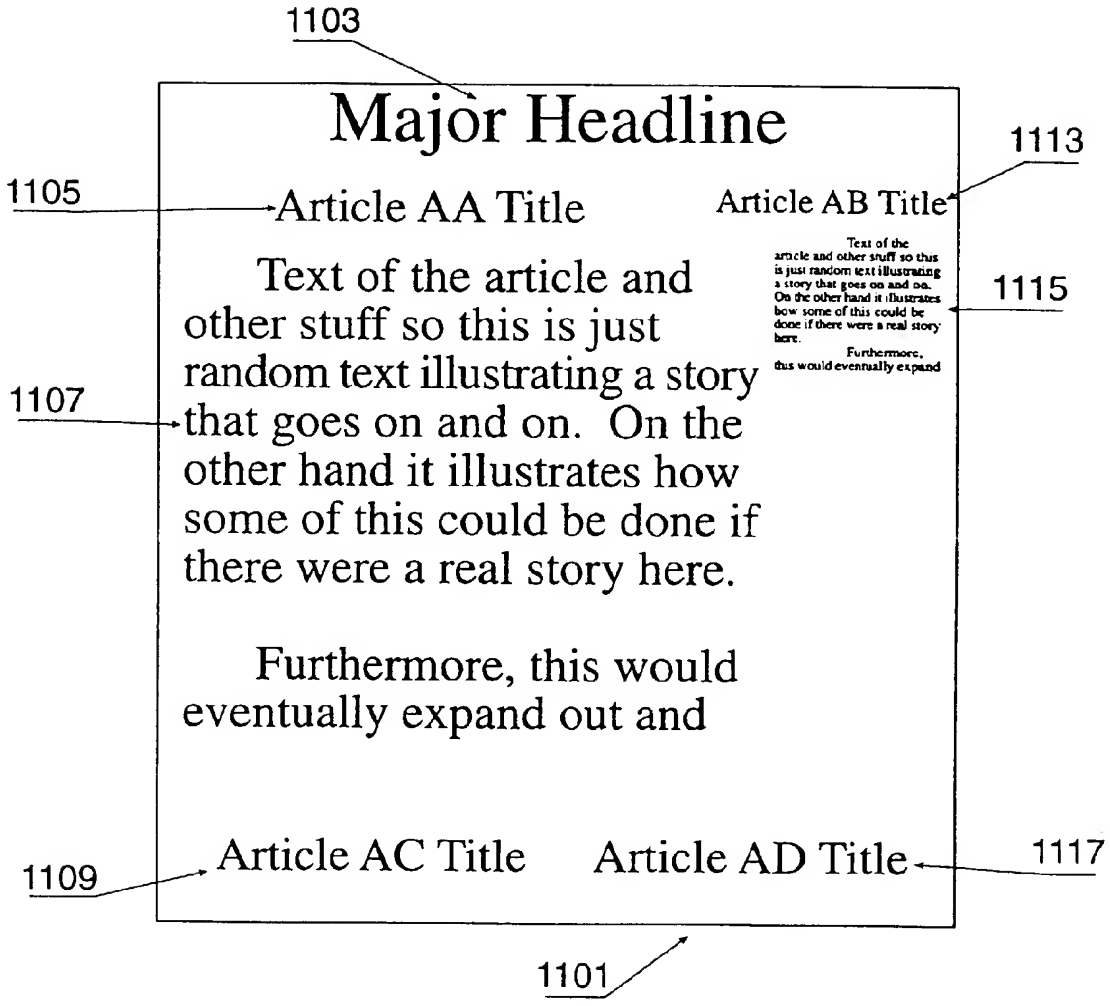
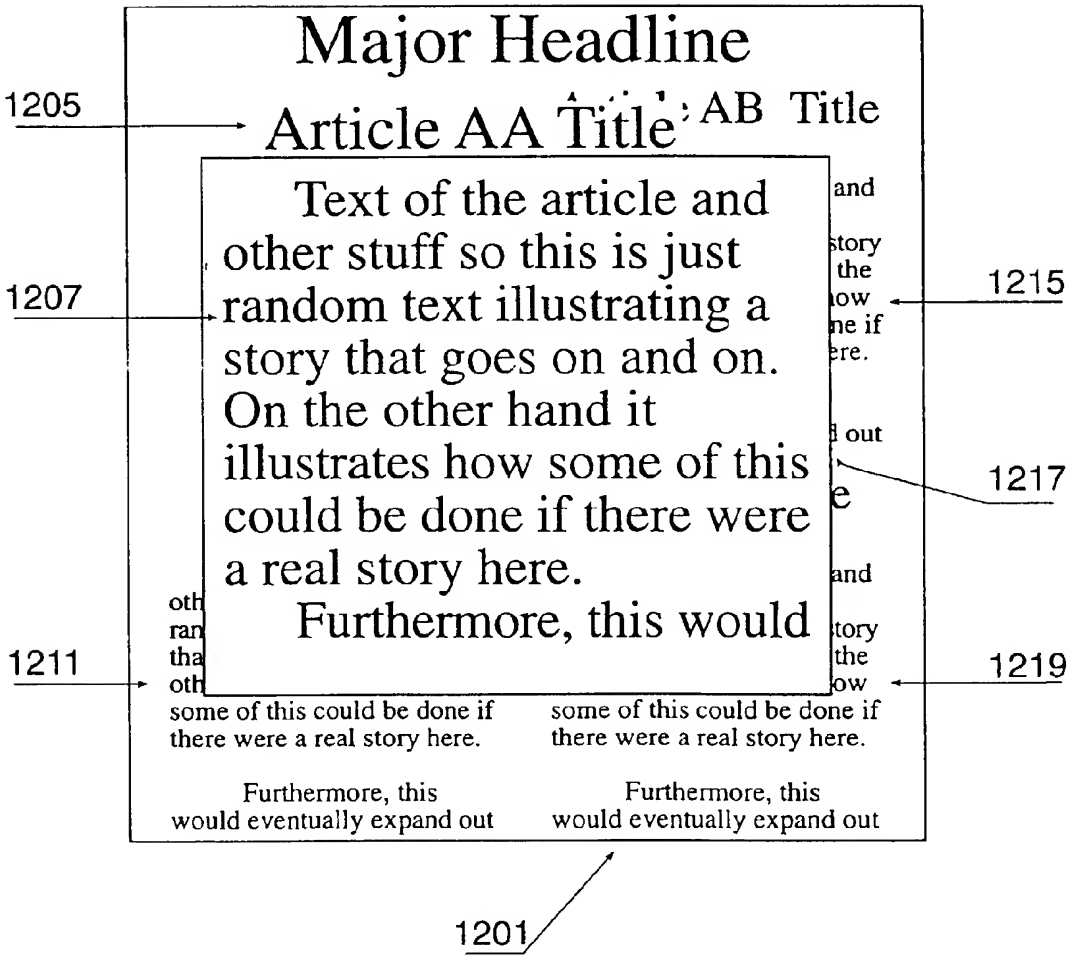

1103
Major Headline
1113
1105
Article AA Title
Article AB Title
Text of the article and other stuff so this is just random text illustrating a story that goes on and on. On the other hand it illustrates how some of this could be done if there were a real story here.
Furthermore, this would eventually expand
1115
1107
that goes on and on. On the other hand it illustrates how some of this could be done if there were a real story here.
Furthermore, this would eventually expand out and
1109
Article AC Title
Article AD Title
1117
1101

FIGURE 11

FIGURE 12


Major Headline
Article AA Title
AB Title
Text of the article and other stuff so this is just random text illustrating a story that goes on and on. On the other hand it illustrates how some of this could be done if there were a real story here.
Furthermore, this would
some of this could be done if there were a real story here.
Furthermore, this would eventually expand out
some of this could be done if there were a real story here.
Furthermore, this would eventually expand out
1205
1207
1211
1215
1217
1219
1201

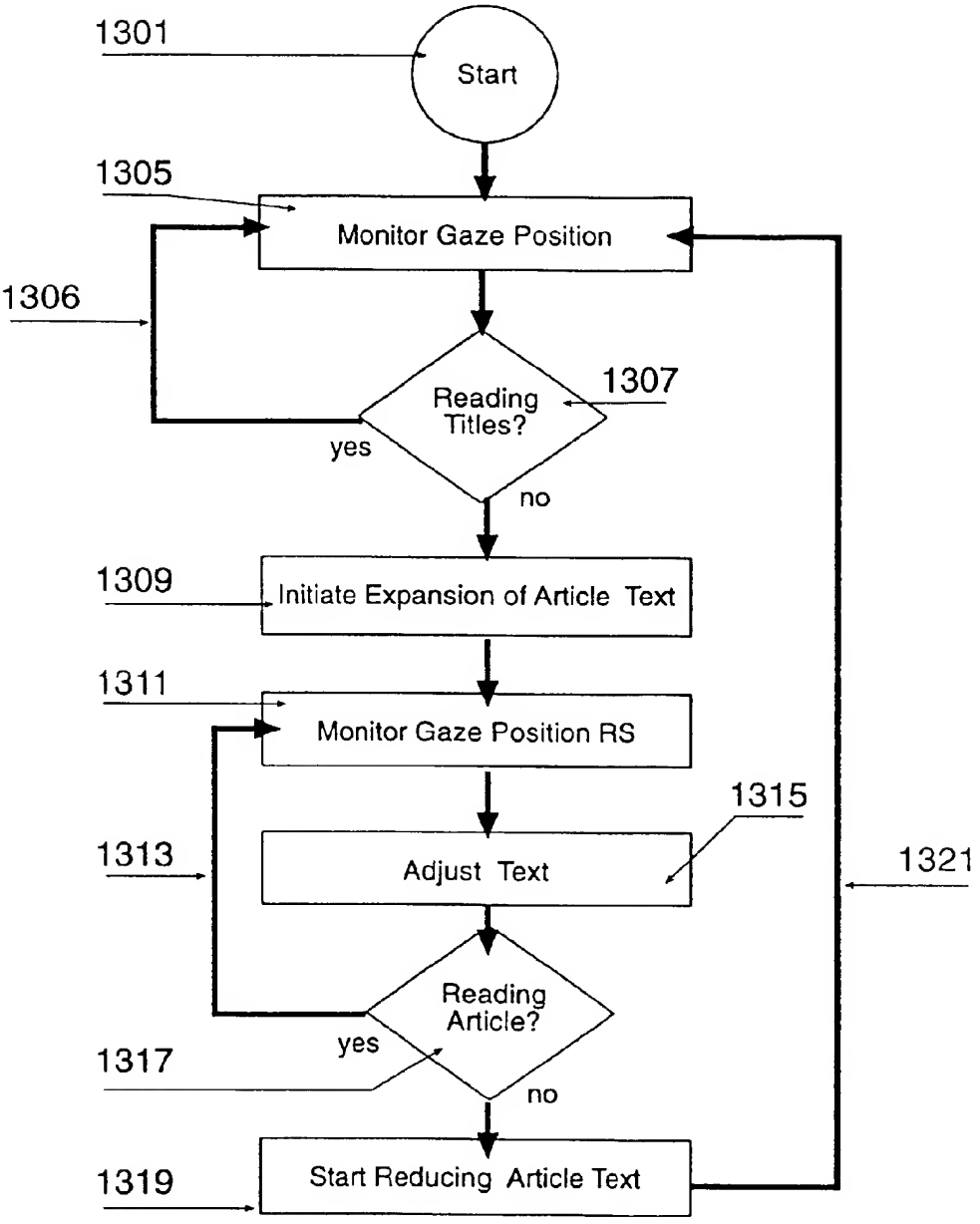

1301
Start
1305
Monitor Gaze Position
1306
Reading Titles?
1307
yes
no
1309
Initiate Expansion of Article Text
1311
Monitor Gaze Position RS
1315
1313
Adjust Text
1321
Reading Article?
yes
1317
no
1319
Start Reducing Article Text

FIGURE 13

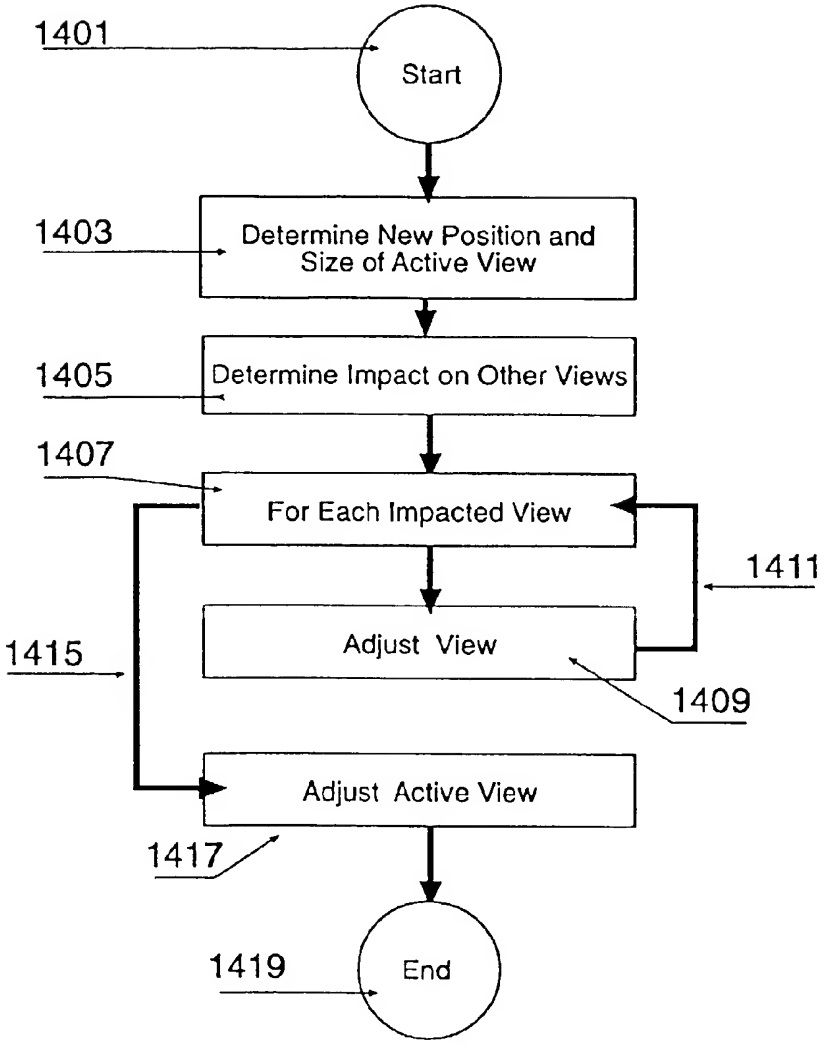

1401
Start
1403
Determine New Position and Size of Active View
1405
Determine Impact on Other Views
1407
For Each Impacted View
1411
Adjust View
1415
1409
Adjust Active View
1417
1419
End

FIGURE 14

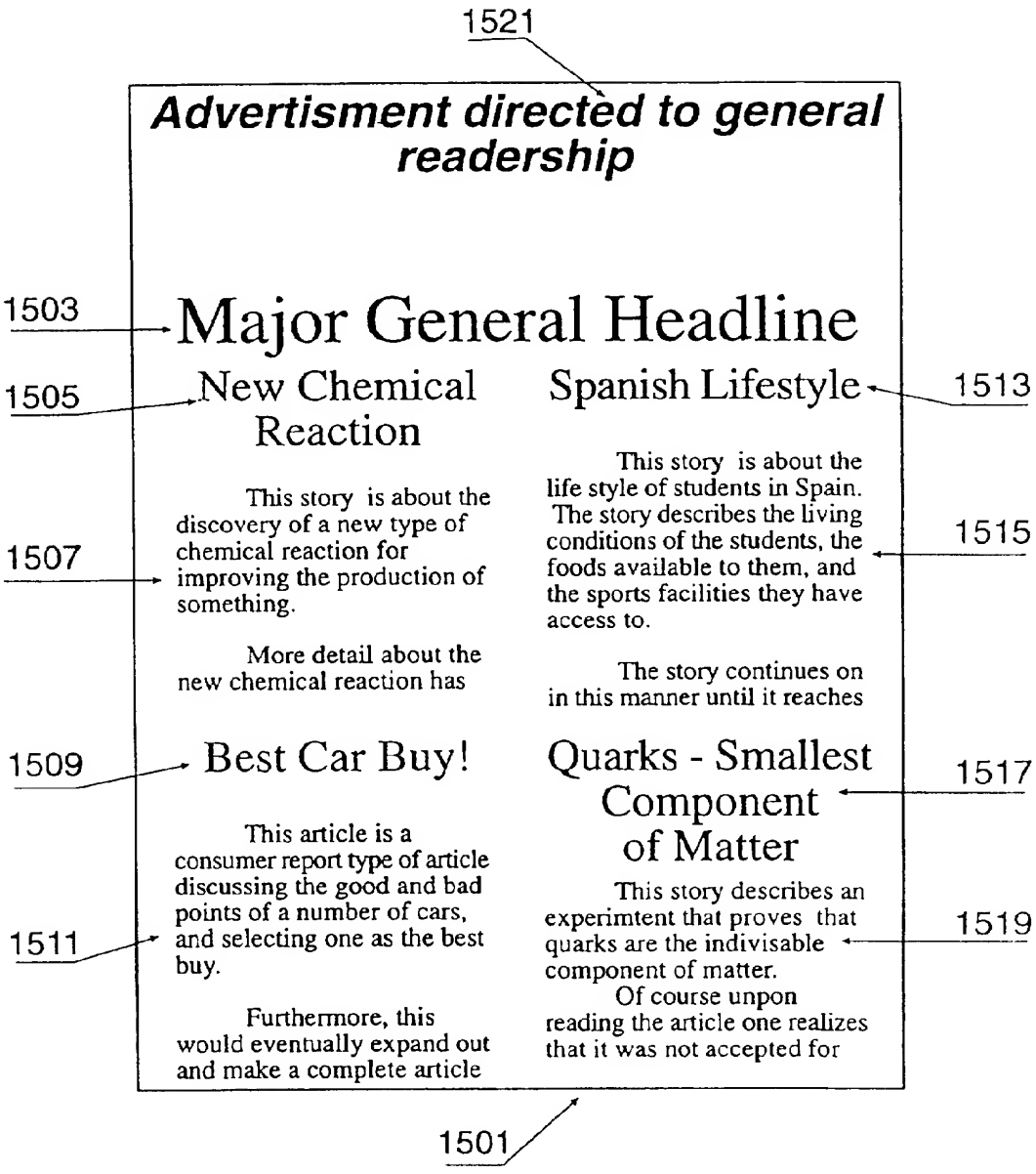

1521
Advertisment directed to general readership
1503
Major General Headline
1505
New Chemical Reaction
This story is about the discovery of a new type of chemical reaction for improving the production of something.
1507
More detail about the new chemical reaction has
1509
Best Car Buy!
This article is a consumer report type of article discussing the good and bad points of a number of cars, and selecting one as the best buy.
1511
Furthermore, this would eventually expand out and make a complete article
Spanish Lifestyle
1513
This story is about the life style of students in Spain. The story describes the living conditions of the students, the foods available to them, and the sports facilities they have access to.
1515
The story continues on in this manner until it reaches
Quarks - Smallest Component of Matter
1517
This story describes an experimtent that proves that quarks are the indivisable component of matter.
1519
Of course unpon reading the article one realizes that it was not accepted for
1501

FIGURE 15

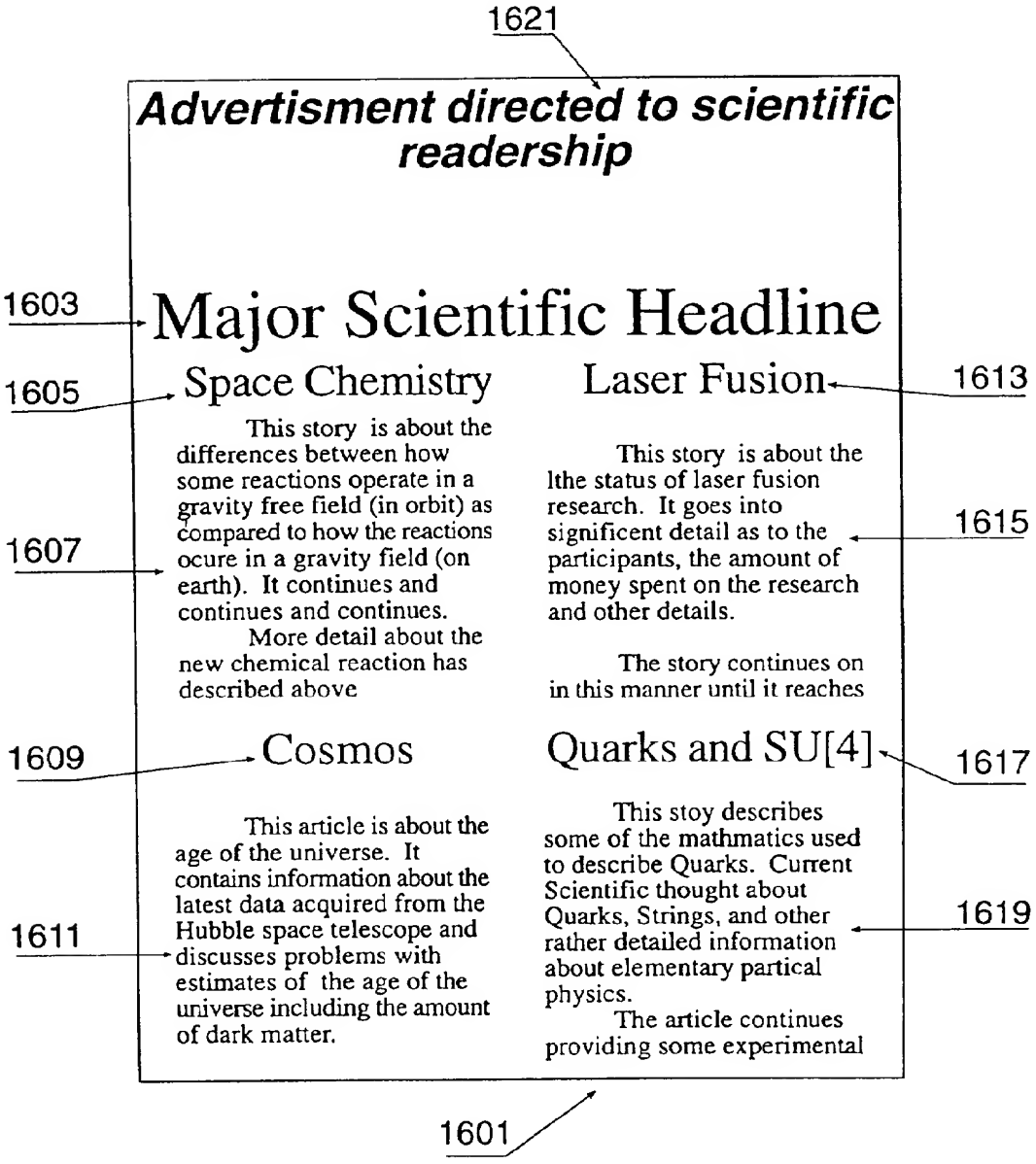

1621
Advertisment directed to scientific readership
1603
Major Scientific Headline
1605
Space Chemistry
This story is about the differences between how some reactions operate in a gravity free field (in orbit) as compared to how the reactions ocure in a gravity field (on earth). It continues and continues and continues.
More detail about the new chemical reaction has described above
1607
1609
Cosmos
This article is about the age of the universe. It contains information about the latest data acquired from the Hubble space telescope and discusses problems with estimates of the age of the universe including the amount of dark matter.
1611
Laser Fusion
1613
This story is about the lthe status of laser fusion research. It goes into significent detail as to the participants, the amount of money spent on the research and other details.
1615
The story continues on in this manner until it reaches
Quarks and SU[4]
1617
This stoy describes some of the mathmatics used to describe Quarks. Current Scientific thought about Quarks, Strings, and other rather detailed information about elementary partical physics.
1619
The article continues providing some experimental
1601

FIGURE 16

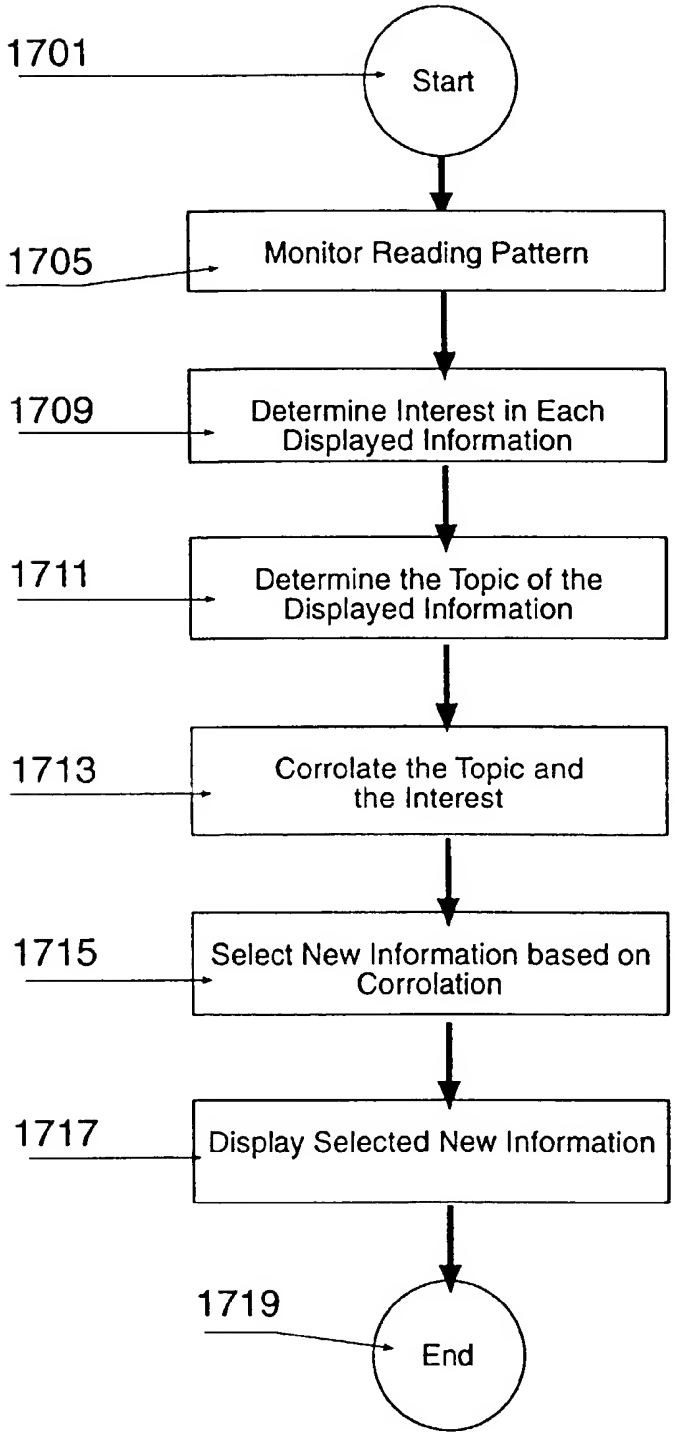

1701
Start
1705
Monitor Reading Pattern
1709
Determine Interest in Each Displayed Information
1711
Determine the Topic of the Displayed Information
1713
Corrolate the Topic and the Interest
1715
Select New Information based on Corrolation
1717
Display Selected New Information
1719
End

FIGURE 17